

# Computers & Electronics

\$2.25

NOVEMBER 1983

Timex Sinclair's New \$199 Computer  
Experimenting with Wireless Joysticks  
Customizing an Apple with EPROMs



SPREADSHEET POWER  
IN THE PALM  
OF YOUR HAND







# ALL MINI DISKS COME ERROR FREE.

**THE HARD PART IS MAKING SURE  
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A disk is built with certain safeguards. That's why most disk makers offer guarantees that the product you receive comes to you error free.

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**Memtek Products' latest innovation...  
acknowledgment of a real world  
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Premium, double and quad density minidisks as well as 10- and 15-minute computer cassettes and a 5 1/4" disk drive head cleaner.



**WE PLAY  
FOR KEEPS™**







# Computers & Electronics

NOVEMBER 1983

VOLUME 21, NUMBER 11

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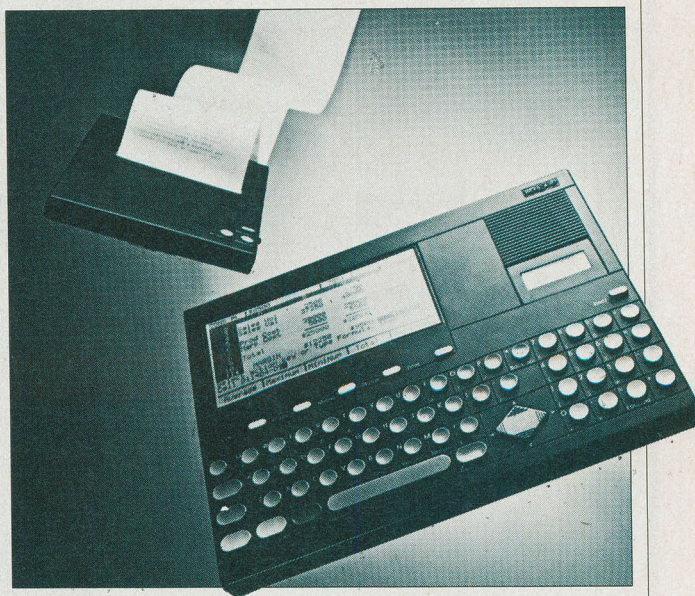
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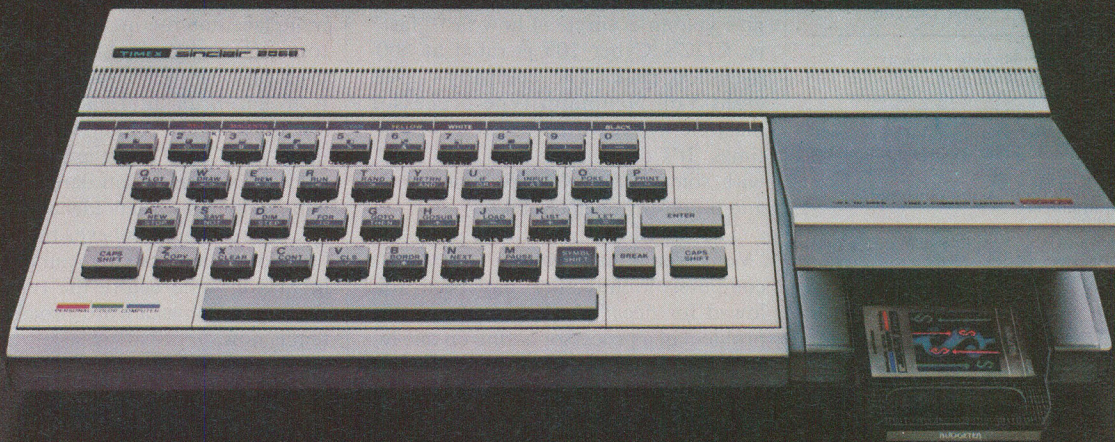
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Now from Timex...a powerful new computer.

# 72K COLOR SOUND UNDER \$200



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## EDITORIAL



## Future Speed Shock

**W**E love speed for speed itself. Beyond mere numbers, how-  
 ever, some computer applica-  
 tions desperately need every bit of extra  
 speed that can be squeezed out. For ex-  
 ample, there's never sufficient comput-  
 ing speed for artificial intelligence, bal-  
 listics, and other complex challenges.  
 What's needed is another revolution in  
 computer design.

In the beginning there was the vacu-  
 um-tube computer, ENIAC. Clearly  
 not a desktop computer, it covered 1500  
 sq ft, weighed 30 tons, and contained  
 about 18,000 vacuum tubes. Supplanted  
 by transistors, then integrated circuits,  
 computers became faster, smaller, and  
 cheaper.

However, you won't see numbers like  
 4.5 MHz among the big daddy's of com-  
 puters, say, Control Data Corp., Cray,  
 NEC, Hitachi, and Fujitsu, among oth-  
 ers. With these supercomputers, speed  
 is measured in gigaflops (billion float-  
 ing-point operations per second). To  
 give you an example of how fast "fast"  
 is, CDC's Cyber 205 is rated at 800-  
 megaflop peak. The company's 2XX  
 eight-Von Neumann-type-processor  
 machine will reportedly beat this by 40  
 times. It's due on the streets in 1987,  
 with some 20,000 CMOS logic arrays  
 and liquid-nitrogen cooling.

The speed barrier, though, is still  
 "Von Neumann," whose serial-style  
 computer architecture has been fol-  
 lowed for decades. To get around the  
 problem of a processor acting on one in-  
 struction at a time, cryogenic devices  
 that use superconductivity have been  
 developed in the labs, such as IBM's  
 Quiteron and Bell Labs' Josephson  
 junctions. Using a few processors with  
 enhanced control-flow architecture is  
 another approach to faster computers.  
 But the real future for super speed

seems to lie in parallel architecture—  
 using hundreds of processors in parallel  
 to speed up data flow. Just imagine the  
 switching network required to handle  
 this, not to mention the software  
 requirements!

Most advanced industrialized coun-  
 tries have companies working on super-  
 speed computer technology. Japan's  
 vaunted "Fifth Generation" computer,  
 with a government-sponsored \$400-mil-  
 lion in the kitty is one. The 10-year  
 project has 9 years to go, and what will  
 come out of it is anybody's guess right  
 now. But it appears to be Japan's effort  
 to leap frog to the forefront of the com-  
 puter industry, a market outside the  
 country that it has not been able to gain  
 a toehold in when it comes to the basic  
 computer itself and software.

Interestingly, much of Japan's com-  
 puter and electronics success in the  
 world has been owed to technological  
 advances or lower production costs, not  
 marketing. Head on with domestic com-  
 panies without one of these two assets,  
 Japan has not been able to encroach on  
 anyone with its products. It has only a  
 2% share of the U.S. market in \$3,000  
 and over personal computers.

## "Supercomputer speed is measured in gigaflops."

Regardless of which country or com-  
 pany comes up with a speed break-  
 through, you can be sure such advances  
 will filter down in time to lower-cost  
 computers. When this happens, artifi-  
 cial-intelligence computers will be com-  
 monplace, interacting with their opera-  
 tors to make decisions and solve  
 problems based on judgements made  
 from uncertain information. There are  
 already scores of AI knowledge systems  
 used, you know. Some are in the medi-  
 cal field, where patient data is analyzed  
 and possible disorders identified.

Chances are, I believe, that a facile  
 "thinking" and talking computer will  
 be at your side before the turn of the  
 century, much as a word-processor sys-  
 tem is now.

*Art Salsberg*





# Reliable.

## You can count on 3M diskettes. Day after day.

Just like the sun, you can rely on 3M diskettes every day. At 3M, reliability is built into every diskette. We've been in the computer media business for over 30 years. And we've never settled in. We're constantly improving and perfecting our product line, from computer tape and data cartridges to floppy disks.

3M diskettes are made at 3M. That way, we have complete control over the entire manufacturing process. And you can have complete confidence in the reliability of every 3M diskette you buy.

Look in the Yellow Pages under Computer Supplies and Parts for the 3M distributor nearest you. In Canada, write 3M Canada, Inc., London, Ontario. If it's worth remembering, it's worth 3M diskettes.



3M hears you...

# 3M

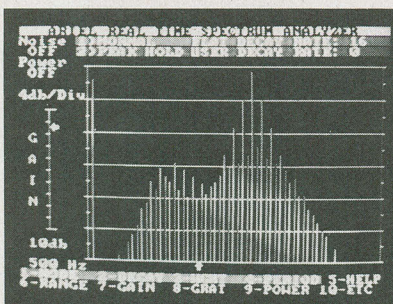
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# NEW PRODUCTS

## VIDEO INFORMATION TERMINAL

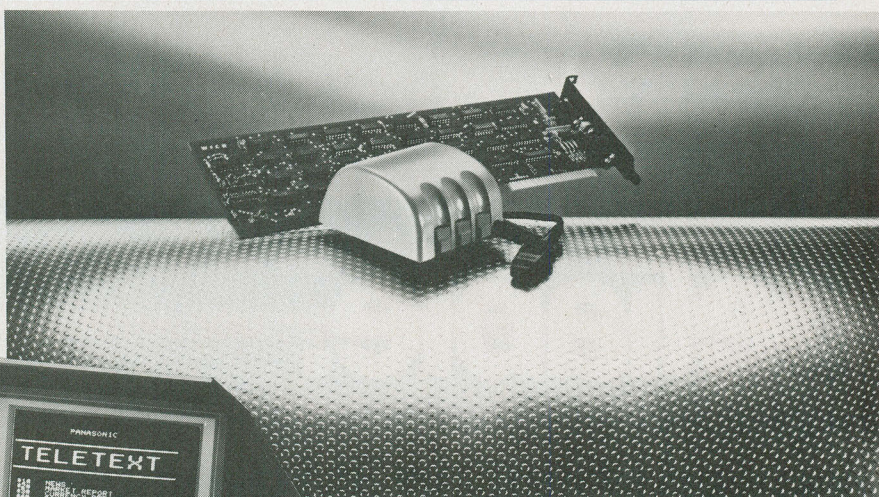
Matsushita's new portable, rear-projection TV weighs 6.6 lb. It can be used as a desktop video terminal for Teletext and Videotex and other video information services as well as a regular broadcast receiver. The collapsible set folds down into a 12" case and operates on either ac, dc, or rechargeable batteries. The set contains three 2" projection tubes for red, green, and blue, and a flat square screen with Fresnel/lenticular surface. Horizontal viewing angle is  $\pm 30^\circ$ ; vertical viewing angle,  $\pm 15^\circ$ . It also has a video input terminal for VCR hookup. Power consumption is 12 W.



## IBM PC SPECTRUM ANALYZER

The Ariel RTA 331 is a 1/3-octave a-f spectrum analyzer that plugs into a single expansion slot in the IBM PC. It divides the spectrum into 31 bands from 20 Hz to 20 kHz and displays the relative amplitude of each frequency band. The unit also converts incoming audio into 8-bit digital words for storage in the PC's memory. \$649.95.

Circle No. 84 on Free Information Card



## COMPUTER MOUSE

Wico's new Computer Command™ "Mouse" is an optically encoded mechanical cursor controller for use with Apple II and IBM PC personal computers. By simply sliding the hand-held device across a desktop surface, computer users can edit, draw lines, or select menu choices from the CRT without touching the keyboard. It features light-encoded wheels and multiple-function buttons and comes with a hardware interface controller card and a 5' connecting cord. The Mouse with interface is \$180 for an Apple II and \$230 for an IBM PC.

Circle No. 85 on Free Information Card

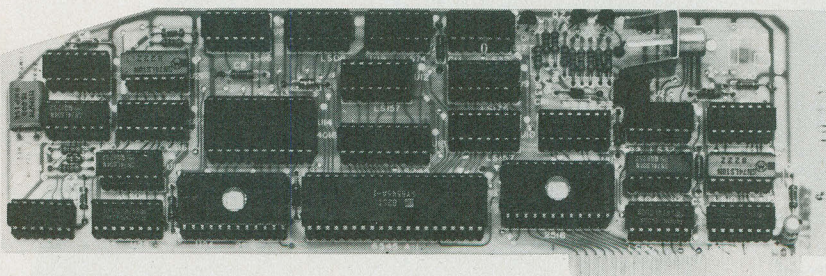




### MONITOR FOR APPLE II

Apple has announced a monochrome video display designed to blend with its Apple II family of personal computers. It features high-resolution, 80-column text and graphics display; an anti-reflective, high-contrast screen; and a tilt mechanism for adjusting the screen's angle. The 12" screen displays up to 24 lines of 80 characters of text in P31 green phosphor. A contrast control knob is located on the right side of the monitor; and other controls for vertical hold, vertical amplitude, and brightness are located on the back. \$229.

Circle No. 86 on Free Information Card



### FRANKLIN 80-COLUMN CARD

The ACE Display card from Franklin Computer expands the video display capabilities of Franklin ACE 1000 and Apple II computers to a full 80 columns by 24 lines to provide ease of viewing and versatility. The card provides four cursor choices. It can be displayed as a blinking block, a nonblinking block, a blinking line, or a nonblinking line. The display card also offers reverse video as a standard feature. In addition, it accommodates the full upper- and lower-case 128-character ASCII set, including line-drawing graphics. The character

matrix is 7 × 9 in a 9 × 10 field. Lower-case characters have true descenders that don't run into the line below.

The display card operates automatically, switching between 40 and 80 columns and between text and graphics to suit the program in use. It operates with CP/M and PASCAL programs. It is offered as an accessory for the ACE 1000 and Apple II computers, and is included as standard equipment with the ACE 1200 computer. Available at authorized Franklin dealers. \$199.

Circle No. 87 on Free Information Card

## COMPUTER SOURCES

**Apple Case.** If you carry around your Apple, Atari, or VIC-20/64, along with a disk drive, small printer, etc., then you should take a look at the Microcase. The heavy-duty plastic case is lined with 5" dyecut foam to support the computer, two disk drives, printer, cable, manuals, etc. The case weighs under four pounds and is waterproof, machine washable, and resists water and mildew. It comes in a variety of colors. **Address:** The Casemaker, 1754-C Junction Ave., San Jose, CA 95112 (408-971-8711).

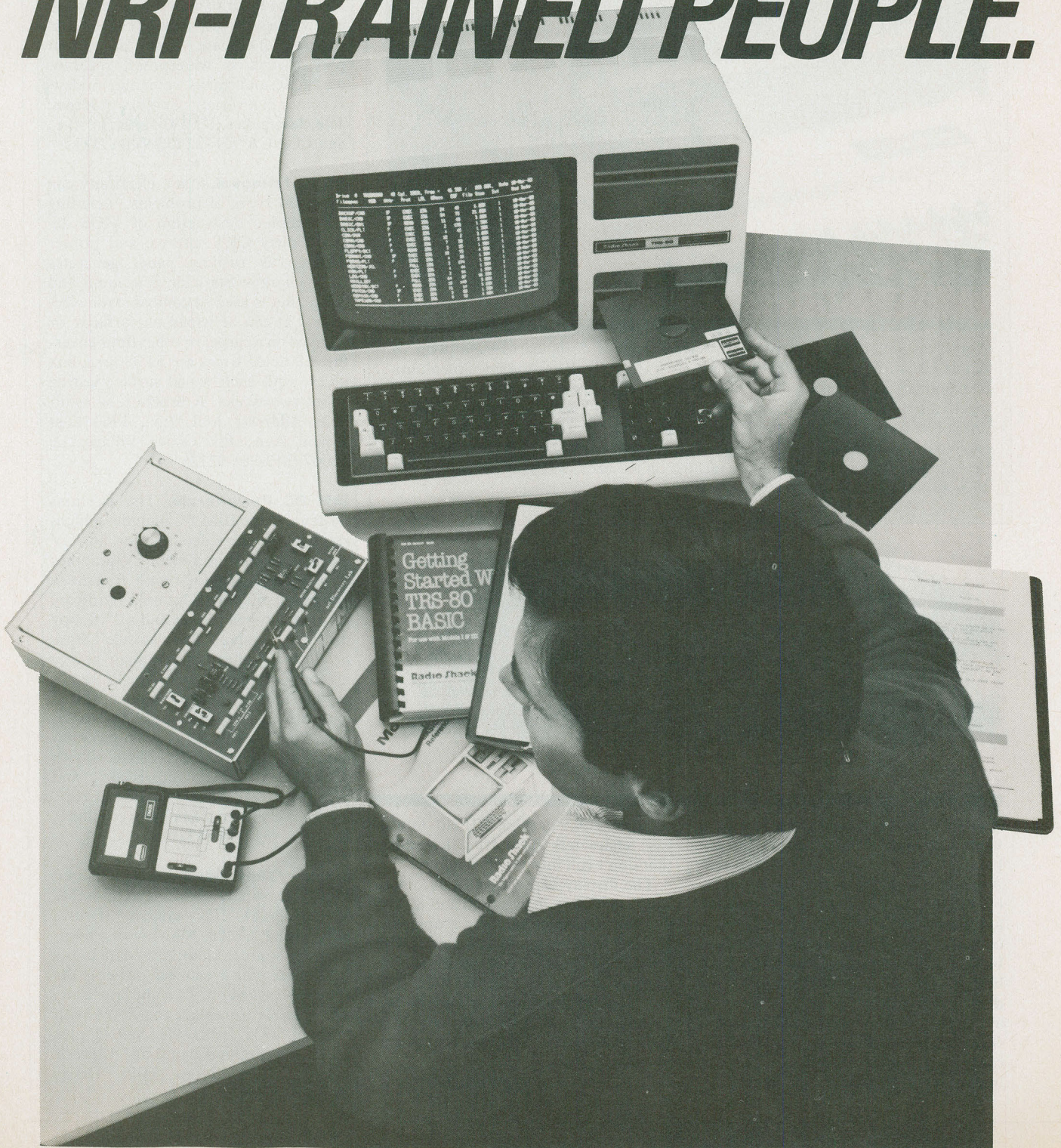
**Static Removal.** Static electricity can cause all types of problems, including catastrophic destruction of MOS devices, dirty CRT screens, and printer damage as rushing paper generates large charges. Staticide is a liquid and spray that is used to combat static electricity. It can be wiped on surfaces, or sprayed on a carpet or other floor covering. Staticide wipes are \$4.98 for a box of 24, with each wiped surface lasting about two weeks. A brochure is available. **Address:** ACL Inc., 1960 East Devon Ave., Elk Grove Village, IL 60007 (312-981-9212).

**IBM PC Peripherals.** The Business System for the IBM PC includes a high-resolution color video monitor, an X-Y coordinate plotter, a memory/graphics expansion interface and Business Graphics software. Optional hardware includes a 6-pen plotter and a 3" floppy disk drive system. The package allows producing professional-looking graphics and more than doubles the PC memory capacity. Data can be documented with pie charts, bar charts, horizontal bars, lines, points, areas, or any combination of graphics, and it interfaces with dBaseII, VisiCalc, SuperCalc, and WordStar. **Address:** Amdek Corp., 2201 Lively Blvd., Elk Grove Village, IL 60007 (312-364-1180).

**Sinclair/Timex Memory Kit.** The kit fills the transparent 8K between 8-16K of the ZX81 16K system. It uses HM6116LP CMOS RAM with a built-in power source. This allows data in the RAM to remain even when power to the system is turned off. At some later date, it is possible to replace the RAM with 2716 or 2732 EPROMs. \$29.95 plus \$1.95 shipping and handling. **Address:** Hunter, 1630 Forest Hills Drive, Okemos, MI 48864.



# ***COMPUTERS ARE CREATING JOBS FOR NRI-TRAINED PEOPLE.***









# NEW PRODUCTS

**IBM PC Word Processor.** The Leading Edge Word Processor is designed to take full advantage of the features of the IBM PC. All edit and format commands can be performed with one or two keystrokes, utilizing function keys, etc., rather than a control-key sequence. Keyboard overlays and a keyboard reference chart are available for ease of learning and use.

The word processor is screen oriented so that, for the most part, what you see on the screen is what you get. An exception is the proportional spacing feature, which does not appear on screen but can be printed. Menus direct the novice user, but experts can override them for maximum speed.

All normal word-processing functions such as insert, delete, block move, etc. are included. Among the more sophisticated functions are a split-screen feature that permits calling up two documents on the same screen (in two windows) and transferring copy between them; an I/O spooler that permits printing one document while editing another; a transposition of characters feature that speeds correction of typos such as "fo" to "of"; and a "Go To" function that enables a user to quickly call up any page within a document.

A variety of printers are supported, foremost those that are marketed by Leading Edge. For printers not specifi-



## 68000 FOR THE IBM PC

A processor board from Sritek Inc. turns an IBM PC or XT into a 68000-based, multi-user, COBOL-oriented computer and provides 8088-based machines with a powerful paged-memory management unit to perform address relocation and memory protection. It also increases system execution speed by using the 68000 for central processing and the 8088 as an I/O processor. It is available at 8 or 10 MHz. With RM/COS and 256K of memory, \$2495. Add 256K, \$2995.

Circle No. 88 on Free Information Card

cally supported, a generic printer driver allows one to select necessary parameters. Commands such as boldface, double-wide, double-high/double-wide, superscript, subscript, underline, and double underline avoid having to embed control codes in the document to exploit the full capabilities of a particular print-

er. A selection of character fonts and colors is also available. A "hot print" feature enables the user to highlight any text in a document and have it printed out with just a touch of the print key.

The Leading Edge Word Processor uses a cache-memory technique, which means that input is constantly saved to disk. This gives it a virtual memory that can store documents up to 32M bytes long. It also means that any type of power failure would affect only a small portion of the document. When a disk is full, the user is signaled, and asked to segment the document at an appropriate place before proceeding.

Planned enhancements for the Leading Edge Word Processor are a mail merge, spelling checker, and thesaurus. Also, a compatible financial spreadsheet is under development.

The complete package includes a program disk; manual, quick-reference guide; keyboard overlay; and a cue card. The manual is said to avoid technical language and is written "by an end user for end users." The word processor runs on the IBM PC with PC-DOS and 128K RAM. Although it's possible to use the package with one disk drive, two disk drives are strongly recommended. Suggested retail price is \$300. **Address:** Leading Edge Products, Inc., 225 Turnpike St., Canton, MA 02021 (800-343-6833).

## COMPUTER SECURITY

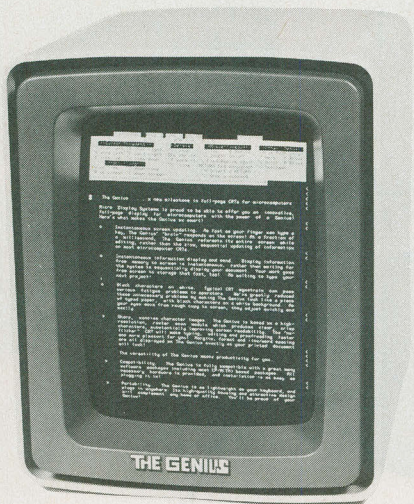
The Omni-Lock, from Micro-Metrics, is a security system designed for the Apple II and III or the IBM PC to allow keyboards, disk drives, and video monitors to be locked in place by a single lock on the shelf spindle. When unlocked, the shelves automatically swivel 360° to allow access to internal cards. Rotation of the shelves permits re-positioning of components for maximum user convenience.

Circle No. 89 on Free Information Card





**Apple Graphics Upgrade.** The Arcade Board is a sprite-graphics and sound effects board for the Apple II, II+, and IIfx computers. It generates arcade-quality color graphics and sound effects. Using the TMS9918A Video Display Processor and the AY-3-8910 Programmable Sound Generator, it features 16 colors in all three graphic modes, two HiRes modes with  $256 \times 192$  pixels, 32 sprites for animation, and 16K bytes of RAM for storing up to 14 pages of high-resolution 16-color graphics. It also has LoRes of  $64 \times 48$ , 60-Hz interrupt for synchronized page flipping, three independent sound channels with 9-octave range and separate volume control, noise generator, and automatic envelope control. \$225. **Address:** Third Millennium Eng. Corp., 1015 Gayley Ave., Suite 394, Los Angeles, CA 90024 (213-473-2102).



### FULL-PAGE DISPLAY

"The Genius" is a full-page display from Micro Display Systems that features a high-resolution, high-density monitor, reverse or normal video, 57 lines by 80 characters and flashing attributes. The Model 101 is for Apple II and IIfx, Franklin Ace 1000 and 1200; and the Model 102 is for a standard RS-232 port. The full-page display is available in a choice of phosphors or screen filters, in green or amber.

It is designed for word processing, financial modeling, text editing, and software development and functions at up to 19.2K baud with all interface functions controlled by a Z80 microprocessor. Internal memory of 16K provides buffering and an internal screen memory. \$1795.

Circle No. 90 on Free Information Card



### LOW-COST 80-COLUMN PRINTER

The Alphacom 81 can print 80 characters (one line) per second and combines a single-chip microprocessor with an Olivetti THM-125 dot-matrix print mechanism. \$169.95. Circle No. 91 on Free Information Card

**Singing Speech.** The Voicebox for the VIC 20 and 64 computers plugs directly into the user port and has its own speaker, volume and pitch controls, and an unlimited vocabulary potential. It incorporates a machine-language text-to-speech program that can be merged with BASIC and occupies only 2033 bytes of RAM; an on-screen "face" whose mouth moves in sync with the speech; special instructions for use with BASIC programs; a program that allows the face to sing; and a spelling quiz program featuring both the speaking face and a vocabulary of 75 words. \$95. **Address:** The Alien Group, 27 West 23rd St., New York, NY 10010 (212-741-1770).

**Color Basic Compiler.** The Color BASIC Compiler allows Radio Shack Color Computer users to write programs in BASIC and then compile them to run as much as 40 times faster. It features a total of 46 commands and functions, most of them a subset of Extended Color BASIC. The Color Compiler generates position-independent machine-language code that lets the program reside anywhere in memory, even in a ROM-pack. The utility requires a Color Computer with 32K of RAM and at least one disk drive. \$39.95. **Address:** Computerware, Box 668, 4403 Manchester Ave., Suite 102, Encinitas, CA 92024 (619-436-3512).

### COMPUTER OPERATES IN FORTH

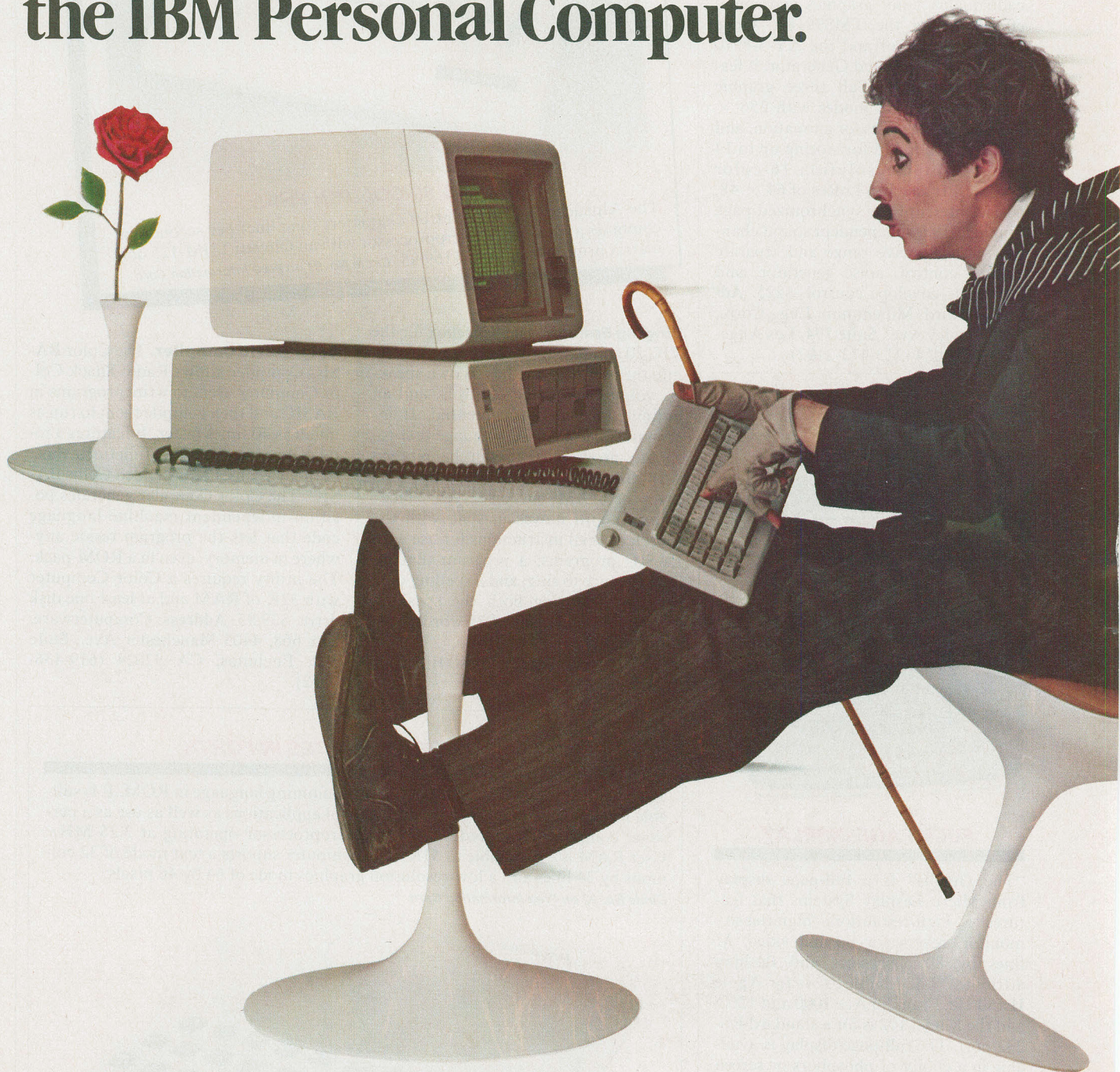
The Jupiter Ace 4000 offers FORTH programming language in ROM. It is suitable for real-time measurement and control applications as well as use as a personal computer. It includes a Z80A microprocessor operating at 3.25 MHz. User RAM is expandable to 51K. The computer supports a text mode of 32 columns by 24 lines and a low-resolution graphics mode of 64 by 46 pixels.

Circle No. 92 on Free Information Card





# How to test drive the IBM Personal Computer.





When you get behind the keyboard of the IBM Personal Computer, hold onto your hat.

It's responsive on short trips.

It's reliable on long hauls.

And it's passing a lot of the others already on the road.

### What's under the hood?

Visit an authorized IBM Personal Computer dealer and test drive the system.

You'll be impressed that a compact with such a great sticker price is also such a powerful performer.

For starters, it's been engineered with *three* microprocessors for better overall responsiveness. A 16-bit microprocessor in the system unit makes the IBM Personal Computer right at home in the fast lane.

Another controls the monitor. And there's yet a third in the keyboard. (Put the keyboard on your lap—it's a perfect example of independent suspension.)

There are 10 function keys that help relieve the tedium of repetitious shifting. (Something like driving an automatic instead of a standard.)

And there are high resolution graphics that could come in first—were there a Grand Prix of personal computers. Get a demonstration of the text and graphics mix. And be sure to see it all in living color. (For more specifics, check out the box at right.)

### Easy acceleration.

Whether you plan on using the IBM Personal Computer to manage a department,

run a business, teach a course, learn a lesson or simply go on a pleasure drive—there's software to head you in the right direction and to help you stay ahead.

While you're at the store, try a few programs—first hand. Even if you've had

#### IBM PERSONAL COMPUTER SPECIFICATIONS

<b>User Memory</b> 64K-640K bytes	<b>Display Screens</b> Color or monochrome High-resolution 80 characters x 25 lines Upper and lower case	<b>Permanent Memory</b> (ROM) 40K bytes
<b>Microprocessor</b> 16-bit, 8088	<b>Operating Systems</b> DOS, UCSD p-System, CP/M-86†	<b>Color/Graphics</b> <i>Text mode:</i> 16 colors 256 characters and symbols in ROM
<b>Auxiliary Memory</b> 2 optional internal diskette drives, 5¼" 160KB/180KB or 320KB/360KB per diskette	<b>Languages</b> BASIC, Pascal, FORTRAN, MACRO Assembler, COBOL	<i>Graphics mode:</i> 4-color resolution: 320h x 200v Black & white resolution: 640h x 200v Simultaneous graphics & text capability
<b>Keyboard</b> 83 keys, 6 ft. cord attaches to system unit 10 function keys 10-key numeric pad	<b>Printer</b> All-points-addressable graphics capability Bidirectional 80 characters/second 18 character styles 9 x 9 character matrix	<b>Communications</b> RS-232-C interface SDL, Asynchronous, Bisynchronous protocols Up to 9600 bits per second
<b>Diagnostics</b> Power-on self testing Parity checking		

no computer experience, you can quickly get into gear.

The driver's manual IBM wrote for you will help simplify matters. And the hardware's been designed to do the same.

### They won't steer you wrong.

The trained salespeople at your authorized IBM Personal Computer dealer realize that you may never have been in this particular driver's seat before.

They want you to relax. They want you to ask any question you want to ask. They're ready and willing to provide you with all the answers—and to help pick the system and the software right for you.

For more information on where to buy the IBM Personal Computer, call 800-447-4700. In Alaska or Hawaii, call 800-447-0890.

You'll see why the IBM Personal Computer doesn't take a back seat to any other system.

**IBM®**

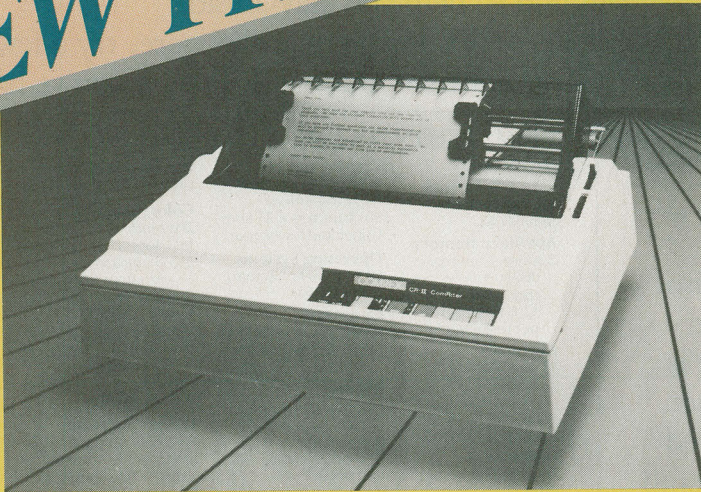
## The IBM Personal Computer A tool for modern times

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# NEW PRODUCTS



## LETTER-QUALITY PRINTING

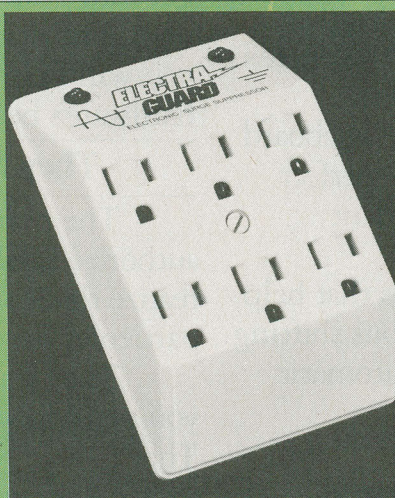
The ComRiter CR-II, from Comrex, provides word-processing features such as superscript, subscript, backspace, underline, boldface, double strike, and proportional spacing. The daisy-wheel printer, with letter-quality printing, has a 5K buffer that allows a user to reproduce original and multiple copies of documents stored in memory. It can store up to 3 pages of data. The CR-II prints at an average speed of 12 characters/second or 140 words/minute. Print motion is bidirectional and logic seeking. The print wheel is an ASCII-standard cassette type with 96 pedals per wheel.

Circle No. 13 on Free Information Card

**IBM Streaming Tape.** The SYSGEN Image for the IBM XT (hard disk version of the PC) includes a controller, drive electronics, and tape drive. It is software compatible with either PC-DOS or CP/M-86. Under software control, the Image will perform complete archival backup from a hard disk at 2.5M bytes per minute. Storage capacity of the cassette is 20M bytes. \$995. **Address:** Sysgen Inc., 47853 Warm Springs Blvd., Fremont, CA 94539 (415-490-6770).

**Clock For Kaypro.** The K-Clock battery-operated, real time clock/calendar for the Kaypro II and IV eliminates the need to constantly re-enter time and date. It plugs directly into a socket in the computer and requires no modifications. A diskette containing clock setting routines is included. \$99.50 (add \$5 shipping/handling). **Address:** Holmes Engineering, 5175 Green Pine Dr., Murray, UT 84107 (801-261-5652).

**Commodore 64 DBMS.** Mirage Concepts' Database Manager is a comprehensive electronic filing system for the Commodore 64 that makes it easy to organize, maintain, and make use of information. The program is written entirely in machine language for speed and can sort on any field at any level. It permits free-form design and input, and allows the use of calculated fields. Hardware requirements are: Commodore 64 computer, Commodore 1541 or 2031 disk drive, Commodore 1525 printer or other parallel printer with interface. \$99.95. **Address:** Mirage Concepts, Inc., 2519 W. Shaw #106, Fresno, CA 93711 (209-227-8369).



## COMPUTER PROTECTION

The Electra-Guard System 2 solid-state clamping device eliminates undetected, submicrosecond overvoltage transients in electrical circuits that can damage unprotected hardware. It has six protected outlets at 15 A and provides clamping protection with a response time of less than 5 ns. \$49.95.

Circle No. 33 on Free Information Card

**VIC-20 Memory Expansio.** The Select-A-Ram is a 64K-byte memory expansion module for the VIC-20 computer. It also provides two expansion slots for program and game cartridges, or additional memory expansion to 192K bytes. Decoding circuitry allows RAM and ROM switching in 8K-byte blocks by inputs from the keyboard or by software command. It plugs directly into the expansion slot of the VIC-20 and

uses the VIC power supply. It also includes write protection, a reset switch, and an optional external power source. \$169. **Address:** Advanced Processor Systems, PO Box 43006, Austin, TX 78745-0001 (512-441-3202).

**Apple Disk Emulator.** The FLASH-CARD is a solid-state disk emulator for the Apple that operates up to 10 times faster than a disk. It is available in 147K-byte and 294K-byte versions and fits in one Apple slot. The system includes the board, DOS 3.3 interface software and manual. CP/M and Pascal interface software is \$50 extra. The 147K version is \$395; the 294K, \$695. **Address:** Syntex Systems, 15050 N.E. 95th St., Redmond, WA 98052 (800-426-7412).

**IBM PC Multifunction Card.** The RAM+3 for the IBM PC and XT provides a time-of-day clock/calendar with battery backup, a parallel printer port, an RS-232 serial port, and options for 256K bytes of additional RAM plus Flash Disk software. It eliminates the need to manually input the date and time each time the system is turned on. The software integrates with DOS 1.1 or 2.0 and the RS-232 port is functionally identical to and compatible with the IBM Asynchronous Communications Adapter. The parallel port is functionally identical to and compatible with the IBM Printer Adapter. The Card can be ordered with sockets but no additional memory for \$320, \$395 for 64K, \$470 for 128K, \$545 for 192K, and \$620 for 265K bytes of RAM. Expansion 64K chip sets are \$80. **Address:** Seattle Computers, 1114 Industry Dr., Seattle, WA 98188 (800-426-8936).



# COMPUTER VIDEO GAMES

## Hands-On Reviews of Recently Released Game Software

### JAWBREAKER

Diskette for Atari 400/800  
Sierra On-Line, Inc., Sierra On-Line  
Building, Coarsegold, CA 93614;  
209-683-6858. \$29.95

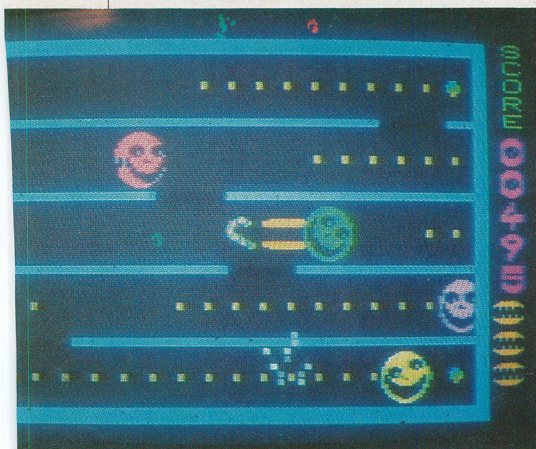
**Graphics** ★★

**Gameplay** ★★

**Sustained Interest** ★★

**Type:** Joystick action game

**Memory Required:** 16K



There are lookalike games and there are pure fun games, and this one is certainly the latter—although there are definitely shades (or remembrances) of Pac-Man that are overshadowed by sheer good times and a few laughs.

You are a set of teeth (they look like the kind my grandmother had—the ones that go into a glass of water every night) that you move back and forth on each of five rows of candy drops. The teeth chomp away, gobbling up goodies, but on each of the five horizontal rows are smiling faces that pull the teeth if they touch you. When that happens, the teeth fall out of the gums in a noisy shower like falling chiclets.

You move from row to row through trap doors that are always in motion—always trying to evade the rolling happy faces. There are also energy candies in each of the four corners of the screen. Eat one of those and you can gobble the happy faces while you're in the energized mode. A bonus candy cane pops up in the middle of row three every so often, also.

Finish a round, and a toothbrush comes out and scrubs the teeth before you start the next go-around. Okay, it may not be Pac-Man, but Jawbreaker is fun and laughs.

### JUICE!

Diskette for Atari 400/800/1200;  
ROM cart for Commodore 64  
Tronix Publishing, Inc., 8295 South La  
Cienega Blvd., Inglewood, CA 90301;  
213-215-0529. \$29.95 (Atari); \$34.95

**Graphics** ★★

**Gameplay** ★★

**Sustained Interest** ★★

**Type:** Joystick strategy/action board

**Memory Required:** 32K

Every so often we see a new game that takes us by surprise because of its interest, originality and playability. Juice! is a one-player game that can keep jaundiced and game-hardened computer people at the joystick for hours.

This is a game that should be especially appealing to readers of this magazine because it involves building a circuit on a checkerboard-like screen that's tilted to provide a three-dimensional view sort of the same way that Zaxxon does. Your hero is named "Edison" and he completes circuit elements by jumping onto each square of the board.

There are bad guys too, and they move down the board (from the top to the bottom of the screen), and one, the Killerwatt, develops legs and starts to chase Edison. To touch any of these creatures is an instant loss of a life and of valuable time. Like many games, you're playing against the clock as well as the many enemies.

When you complete the circuit, current flows in dazzling hues for a moment, your score is totaled, and you proceed to the next screen, which is a little harder. The fourth screen in the first level is strictly a circuit-completion vs. the clock array with no bad guys to bother you. This one is good for bonus points.

Then it's on to Level Two, where the activities get more and more complicated. There is a lightning bolt that moves down the board (Flash) disconnecting all the circuit elements you worked so hard to get into place. You can stop the Flash by touching him, and this earns some bonus points.

There are six levels (we must admit we haven't gotten to the top yet), and high scores are saved on the game disk for future generations to gaze at with

awe. Juice! is an excellent and captivating game, and if it hadn't been for M.U.L.E., it would have been our choice as Game of the Month.

### MOUNTAIN KING

ROM Cartridge for Atari 400/800  
CBS Electronics, 41 Madison Avenue,  
New York, NY 10010; 212-481-6400.  
\$30.00

**Graphics** ★★

**Gameplay** ★★

**Sustained Interest** ★★

**Type:** Joystick action game

**Memory Required:** Resident ROM

This latest CBS cartridge game for the Atari computer is better than most we've seen of its genre, and it takes some heavy-handed practice on the joystick to get a decent score.

Sound effects include electronically synthesized "From the Hall of the Mountain King" by Grieg—rather appropriate, except that in this case, the mountain is tunneled by level after level of labyrinths that you run through gathering diamonds.

There's a treasure chest which you can find in the darkened tunnels only by turning on your flashlight. The object is to capture the crown from the Temple Chamber and carry it safely to the top of the mountain as many times as you can. That's easier said than done, because there are many, many hazards, including a giant spider who wraps you up nicely in a web and then comes back to suck your juices dry (ugh!).

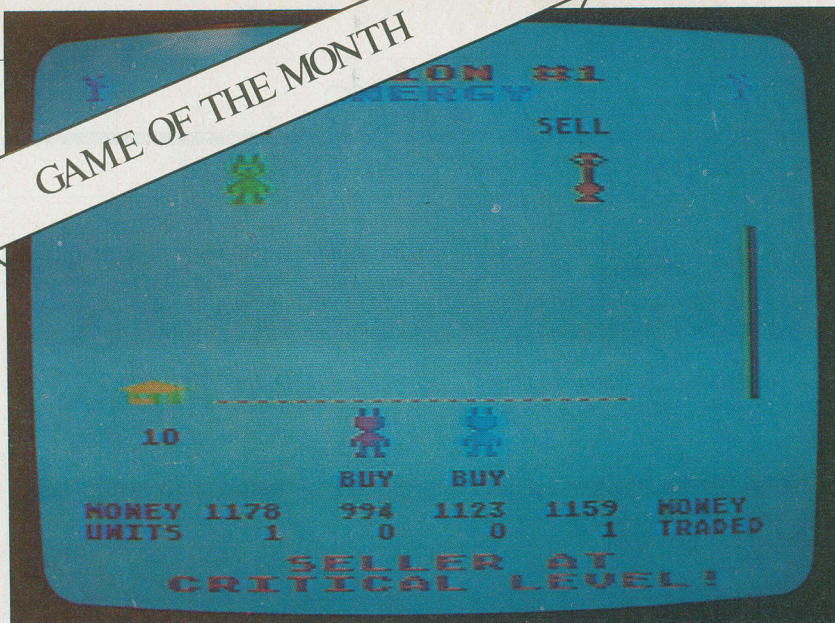


The game is innovative, difficult, and has eight different levels of play. As we said, there are lots of hazards, and once you get killed, the game's over; you get no bonus or free lives here.

(Continued overleaf)



## GAME OF THE MONTH



### M.U.L.E.

Diskette for Atari 400/800  
Electronic Arts, 2755 Camput Drive, San  
Mateo, CA 94403; 415-571-7171.  
\$40.00

**Graphics** ★★★★★

**Gameplay** ★★★★★

**Sustained Interest** ★★★★★

**Type:** Joystick strategy game

**Memory Required:** 48K

M.U.L.E. has got to be one of the most imaginative and intriguing games we've seen in quite a while. Strictly speaking, it's a board-type game done through the medium of the computer. Where to start? The graphics, the sound track and the pure, unadulterated creativity of *everything* are so captivating—even the screen credits have so much entertainment value that it's almost a shame to shut them off to start the game.

M.U.L.E. is a game of one to four players. There are *always* four players; if you're going solo, the computer takes the other three turns. It's one of the few games we've seen that really takes advantage of the Atari 800's four joystick ports, although you can play with just one joystick and pass it around as play turns change.

You first choose your marker color and your creature from a galaxy of fascinating and just plain "cute" extraterrestrial creatures. The scenario then starts with a spaceship landing on an alien planet. The players each can pick a plot of homestead ground during the land grant at the beginning of each round of play. Ideally, you try to get abutting plots covering different areas of production: food, energy and mining for Smithore.

After you get your land, go to the coral in the village and buy a M.U.L.E. (Multiple Use Labor Element) for \$100.

Then have him outfitted for the right kind of work depending on the type of land you have. You start with \$1000 and \$300 worth of goods and try to keep from running out of cash.

How do you get money? You can go into the saloon at the conclusion of your turn where you always win some money at poker. The amount varies depending on how much time is left in your turn. But the real money-crunch comes during the end-of-round auction where you try to sell your surpluses and buy to make up for shortages. This is where the competition among human players can get really cutthroat.

There is a single beginner's playing token that gives the learner an extra \$300 in cash at the game's outset. There are three levels of play: beginner's, standard and tournament games. Until you get really good, it's not a bad idea to stay at the beginner's level.

The imagination of M.U.L.E.'s designers runs rampant. Strange Wampus creatures earn bonus money if you catch them. There are such random events such as planetquakes, acid rain and pest attacks that can destroy your land site or your crops. Your relatives in another galaxy can send you some gifts of food, ore and whatever, which is added to your assets. A status board shows how much surplus (or shortage) of food, energy and Smithore you have at the end of each round of play, followed by three auctions: one each for each of these three categories.

We've heard the game described as a sort of electronic, outer-space Monopoly—and it's very much like that good, old-fashioned great-granddaddy of board games. It has the various chance elements—chosen by a random command in the program instead of a roll of the dice and a turn of the card. There are properties to be acquired and devel-

oped; there is buying and selling and auctioning and total assets to be contended with.

The game is so extraordinarily complex and imaginative, that it's bound to keep this reviewer's household busy for quite a few evenings that should be spent at the word processor instead. Everybody here loves Monopoly, and this love may soon be replaced by M.U.L.E.

### SPELLING BEE GAMES

Diskette for Atari 400/800; Apple II system  
Edu-Ware Services, Inc., Box 22222,  
Agoura Hills, CA 91301-0522;  
213-706-0661. \$39.95 (Atari disk); \$29.95  
(Atari cassette); \$39.95 (Apple disk)

**Graphics** ★★★

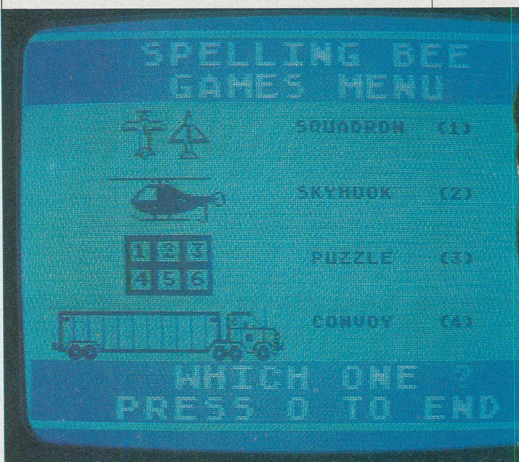
**Gameplay** ★★★★★

**Sustained Interest** ★★★

**Type:** Joystick/keyboard  
educational game

**Memory Required:** 48K

This one is strictly for the kids—ages 5-10—but we couldn't resist having a look to see what today's educational software looks like. We liked what we



saw, because this particular program makes spelling and memory development fun to do.

The spelling invariably involves simple words. You have several ways of "moving" scrambled letters into the correct place to identify the picture in question. You can use a helicopter with a skyhook, guide an airplane past a list of words, targeting in on the correct spelling; you can try to recall the location of each of six hidden pictures after seeing them for just a few seconds; kids can take turns spelling words.

Overall, the graphics and techniques are very well done, and we have to overlook the lack of patience we, as adults, have with seemingly slow-moving spelling processes. But it's great for kids. ◇



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# Bits & Bytes

NEWS, VIEWS & GOSSIP/BY SOL LIBES

## RUMORS & GOSSIP

► Look for **Atari** to unveil an IBM-compatible portable early next year. They thus follow in the footsteps of TI, Commodore and Tandy (the latter two also expected to introduce IBM lookalikes before year-end). This will leave Apple as the only major personal computer vendor not selling an IBM-compatible machine. Atari is also expected to introduce other products that can be used with the IBMs... There are also rumors that Atari may introduce systems with Apple II and CP/M-80 compatibility... **Apple** is expected, early next year, to replace the DOS 3.3 operating system used on the Apple IIe with a new system to be called "ProDOS." It will be compatible with the SOS (Sophisticated Operating System) used on the Apple III, which has a hierarchical file structure and can handle larger files and more disk capacity. Expect Apple to provide software to allow DOS 3.3 programs to be converted to ProDOS format... Also Apple may introduce a new hard-disk system for the Lisa near year end. It should be faster and store more data. Too many customers have complained about the slow program loading... **Hewlett-Packard** is rumored about to introduce a microWinchester drive with a 3½" form factor. Miniscribe, Seagate, and Tandon are also believed readying such units... There are vague hints that **Sinclair** intends to bring out a \$500 business-oriented computer... There are hints that Atari may introduce a 16-bit personal computer early next year... **Commodore** is rumored phasing out the VIC-20 and replacing it with a new machine that is not software compatible. (Why should they change their tactics now?) Speculation is that the Commodore 64 still has about a year's life left in it.

## WOZNIAK BACK AT APPLE

► Steve Wozniak, the designer of the Apple I and II computers, has returned to work at Apple's Cupertino PC Systems Division. He had left two years ago after surviving a plane crash. In the interim, he returned to college to complete work toward a degree and organized the Us Generation Festivals of music and technology, on which he lost a reported \$20 million.

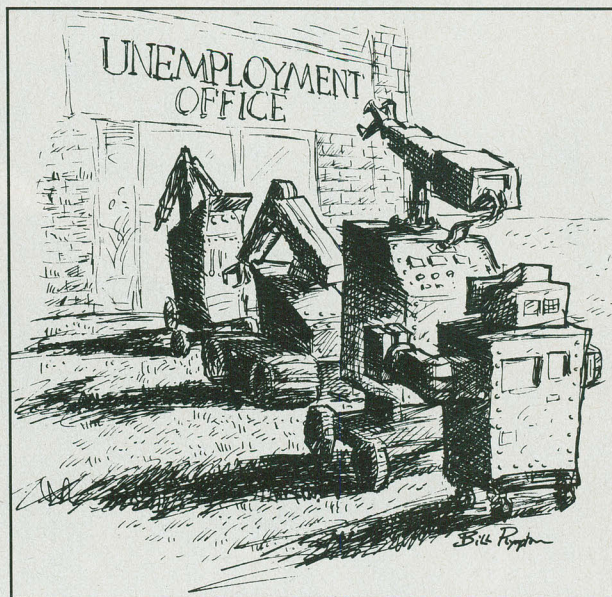
It is rumored that Steve, who is noted for designing "gutless wonder" circuitry, will be working on the design of a new Lisa-like computer that will be less expensive, with fewer parts and more software.

## LAYOFFS HIT PC MAKERS

► Atari, which earlier this year, laid off approximately 2000 workers in its computer games and personal computer divisions, recently announced a consolidation of the two divisions resulting in the layoff of 750 additional workers. The division is now down to about 4000 employees, most outside this country.

Texas Instruments, hard hit by losses in the personal computer area, announced a curtailment of production and the layoff of 750 at two plants which make the 99/4A personal computer. And Mattel Inc., maker of the Intellivision home video game, recently announced that it laid off 260 workers at its game division.

Meanwhile, Commodore, which eight years ago was nearly forced into bankruptcy when TI entered the calculator business (TI supplied the chips Commodore used in its calculators), has reported its best year yet. It now has over 30% of the home computer market and reports earnings of over \$28 million on \$675 million sales. It is shooting for \$1 billion this year. Maybe it has a secret ambition to force TI out of the home computer business. TI, Atari, and Matel, the other leading home computer makers all reported sizeable losses for this past year.



## RECESSION HITS JAPAN ROBOT INDUSTRY

► There are reports that there is a slump in the robot industry in Japan that has caused prices to drop 30% or more. There are currently about 200 companies in Japan assembling robots, and the country, which is about the size of California, has more robots in use than all the rest of the world combined.

## INTEGRATED SYSTEMS BEING INTRODUCED

► At the recent Computer Electronics Show, Coleco Industries shook up the industry by introducing a completely integrated system with an expected retail price of \$600. It includes the basic computer and keyboard, printer, storage device, and application software. Intended to be sold by mass merchandisers, it goes contrary to the current approach where consumers are sucked in with very low prices for the basic machine only to find out that they have to go back to the dealer for additional peripherals and software before they can really use the machine to do useful work. In the end they pay considerably more than \$600.

The Coleco "Adam" system is expected to be in the stores in time for the Christmas season. However, Commodore and Atari are not sitting still. They are expected to integrate com-



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It would be beautiful, a magnificent sleek instrument to enhance any room.

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Every other state-of-the-art phone we've seen handles either just one line or (bulkily) five lines.

The **ELECTRONIC SECRETARY-PHONE** is about half the size of most phones, but its innards are crammed with advanced electronic technology.

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You control two separate phone lines, which means you can have a true multi-line conference call without involving the phone company.

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Best of all, you can touch one key and you'll have a hands-free speakerphone whose sound fidelity is surprising. Your phone has a volume control, of course.

Before we tell you how little it costs, here a few more timesavers and conveniences built into your Electronic Secretary-Phone:

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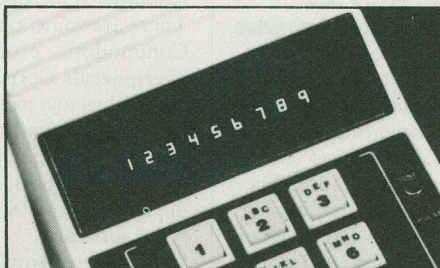
We've seen phones you need an engineer's degree to operate. A child will have no trouble putting this wonder-phone through its paces.

You won't dial a wrong number because an LED display shows you, digitally, the number you're calling.

You can call MCI, Sprint, your computer, or anywhere you need the touchtone signal. A touch of your finger switches back and forth from pulse to touchtone.

Automatic redialling of the last number? Of course. No jangling ringer-bell; the ringer is a pleasant electronic tone.

But we think what you'll like most about the Electronic Secretary-Phone is its beauty. If ever a phone could win an award for design, this is it. You'll be proud to have this phone in your home or office.



LED Display Shows No. Being Dialed.

#### **Get It Far Below Market Place**

We originally planned to sell this phone for \$169.95, and it would be a bargain at that price. When we decided to feature it in our catalog, we lowered the price to \$129.95.

Now we've been able to contract for enough of them that you can own an *Electronic Secretary-Phone* for only \$119.95! At that price, while we have them, you should order two.

Our absolute guarantee means you'll have a month to use this phone and see for yourself that our claims about it are true. Enjoy it!

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Plug in the **ELECTRONIC SECRETARY-PHONE**. Use it for up to 30 days. If you decide for any reason you don't want to keep it, return it for a 100% refund.

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Use the "Hold" button to switch back and forth, Or use them together for conference calls!

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Just push both buttons and both lines are open. They're interactive, so you can tie two calls together!

- **Speaker Phone**

If you have a roomful of people, or if you just don't want to hold the instrument, your Speakerphone has wonderful sound fidelity plus volume adjustment!

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ponents into system packages too. Thus, a purchaser will be able to either buy an individual item or a completely packaged system. For example, a Commodore 64 integrated system that includes a disk drive, printer and choice of a database or spreadsheet program is already being offered for \$799.95. Atari is expected to offer a similar package with its new systems.

It is still not clear whether this integrated approach will catch on in the consumer marketplace. K-Mart, one of the largest mass merchandisers, has already decided that it will not sell integrated systems this Christmas season and, instead, will be selling only separate components. After all, the profits are greater for the dealer when he can use the CPU as a loss leader, with a markup on peripherals and software.

## ATARI TRYING TO REGAIN MARKET SHARE

► Atari, which just a short time ago was the leading producer of video games and personal computers in the U.S., has dropped to third or fourth place in the consumer mass market. Atari reported a loss in the first quarter of almost \$47 million and is expected to show an even greater loss for the second quarter. It recently hired Alan Alda, of M.A.S.H. fame, for a reported \$10 million to represent it in commercials on TV and newspaper ads. They are also providing stores with displays using video discs to sell their systems. Switching to an exclusive distribution organization, the number of distributors has been cut from 190 to 40.

Atari recently introduced four new computer, 16 computer accessories, and a slew of new software packages. A new laser disk-based video game is also in development.

## VDT STUDY RELEASED

► The National Research Council has released a report, sponsored by the National Institute for Occupational Safety and Health, a Federal Agency, on video display terminal safety. They concluded that there is no valid scientific evidence that VDTs adversely affect vision.

There had been charges that VDTs caused eye problems and other health problems. The report concluded that worker complaints they encountered appeared to stem partly from poorly designed VDTs and poorly lighted and designed workplaces, and from the boring, repetitive, low-paying jobs of many workers using VDTs. In 1980 there were more than 7-million workers using VDTs.

## 32-BIT WIDE MULTIBUS ANNOUNCED

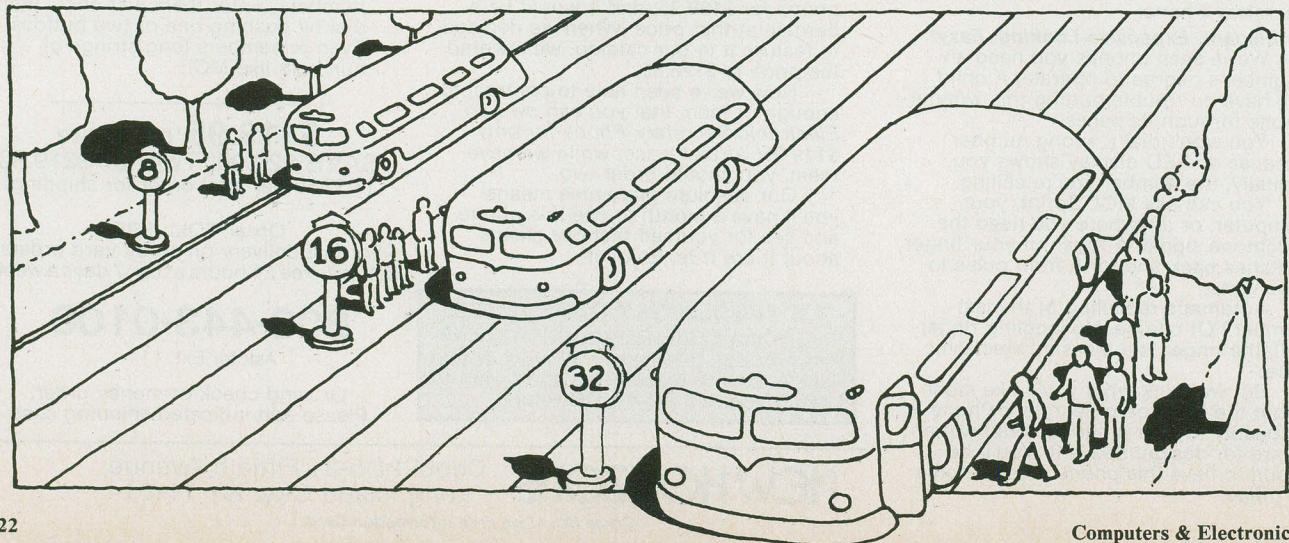
► Intel has announced that it is developing a 32-bit-wide version of its "Multibus" bus, to be called "Multibus-II." Multibus is one of the most popular microcomputer buses used, along with the S-100 and Verabus. Multibus was created in 1976 as an 8-bit-wide system and later upgraded to 16-bit-wide. This latest upgrade is no doubt in anticipation of Intel's introduction of a 32-bit version of its 8086 line of microprocessors. The new version of Multibus is also expected to support several hierarchies of data transfers as well as a hierarchical processor structure for multiprocessor operation.

Intel is also rumored to be working on a VLSI chip that implements all of the Multibus-II interface circuitry and a second chip that will interface the Multibus-II to its new desktop VAX, now in development.

The VME bus, for the Motorola 68000 16-bit processor, already has 32-bit wide capability, and Motorola is known to be far along with its true 32-bit wide version of the 68000. The S-100 bus, which was upgraded to 16-bit capability three years ago (standard was adopted by IEEE last year) can also be expected to be upgraded to 32-bit capability after the 32-bit processor chips become available.

## RANDOM NEWS BITS

► **Standard & Poors**, the outfit that rates businesses, has put Texas Instruments, Warner Communications (Atari parent), Mattel, and Milton Bradley on its "Credit Watch" list... **Commodore** announced over a year ago that a Z80 cartridge for the 64 would be available to run CP/M on the machine. If anyone has seen one on sale, please let me know. There are some available from non-Commodore sources, but Commodore promised a real low-cost one... **Micro-peripherals Corp.** (2565 152nd Ave., N.E., Redmond, WA 98052) has just introduced a receive-only modem to take data from commercial radio stations at up to 4800 baud. Plug it into the earphone jack of your radio receiver and your computer's serial port, and tune in the station. Right now only radio station KMPS, Seattle, WA is transmitting personal computer software... **Apple** recently donated 50 Lisas, valued at \$500,000, to Brown University, Providence, RI, while IBM and DEC donated \$50 million each worth of equipment, software and services to MIT... **Sanyo** has announced the development of a two-layer IC chip.





# MEMOTECH

## The Complete Range

Fifteen months ago Memotech developed the first 64K Memopak, designed to maximise the capabilities of the Sinclair ZX81. Since then, using the ZX81 as a starting point, we've gone on to produce a comprehensive range of Memopaks, adding 16K and 32K memory expansions, utilities packages comprising a Word Processor, Z80 Assembler and Spreadsheet Analysis, plus Communication Interfaces, High Resolution Graphics and a professional quality Keyboard. To complete our range of Timex add-ons, we are now introducing the MEMOPAK RS232 Serial Interface.

### RS232 Interface

The RS232 is an all-purpose interface which allows the Timex not only to output to suitable serial printers, but can link up with numerous types of peripheral or even other processors. The Interface has two main modes of operation: BASIC mode allows you to use the range of functions supplied in the RS232 EPROM within an ordinary BASIC program, and TERMINAL mode allows you to use your Timex as a terminal to another processor. The EPROM functions offered permit the user to send, receive and convert bytes between Z80 code and ASCII, as well as check the status of numerous control flags. Received or transmitted data can appear simultaneously on the screen, and received data may be printed simultaneously.

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The BASIC commands LPRINT, LLIST and COPY are used to print on any CENTRONICS type printer. All ASCII characters are generated and translation takes place automatically within the pack. Reverse capitals give lower case. Additional facilities allow high resolution printing.

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# LES SOLOMON ON COMPUTER HARDWARE



## Smaller is Better?

**D**URING a recent discussion on the relative display merits of video monitors and TV receivers, a couple of people asked why it is that a small-screen TV receiver displays a much "smoother" picture than a large-screen version. And, if this is true, wouldn't this make a small-screen TV receiver ideal for computer readout?

Let us take a look at what produces this "smoother" visual effect on a small screen.

No matter where the video originates—from a computer or TV receiver, it must modulate the electron beam of the display CRT to create the visual image. In the case of color, three electron guns have to be modulated. However, in this example, we will just discuss one electron gun since the same thing happens if there are more than one.

As shown in Fig. 1, the electron beam leaves the CRT "gun," is propagated down the CRT and "squeezed" by the focus electrode to come to a sharp point where the electron beam impinges on the phosphor that coats the inside of the faceplate.

When the electron beam strikes the phosphor, it causes photons to be emitted, thus producing a bright spot. The brightness of the spot is determined by the beam modulation produced by the video signal and the setting of the system brightness and contrast controls. The position of the bright spot along the particular trace is a function of the horizontal sweep system.

The bright spot formed by the impact of the electron beam with the phosphor is circular in shape, as shown in Fig. 2. Note also that, as a result of the high velocity impact between the electrons and phosphor, secondary electrons are emitted. After bouncing off the rear of the faceplate, these secondary electrons produce a "halation" ring around the bright spot and a "dark" ring is conse-

quently produced between the bright spot and the partially bright halation ring.

Thus, it can be seen that even if the associated electronic system had the maximum bandwidth, it is the CRT electron beam that actually determines just how small each pixel really is.

Let us examine a couple of scan lines that cover part of a vertical line (Fig. 3). Note that, when the scanning lines are spaced further apart than the halation rings (as would be the case with a 25" CRT), each bright spot is clear and distinct, with the resulting display a trifle grainy-looking due to the gap between the lines. On the other hand, when the scanning lines are close enough so that

the adjacent halation rings overlap (as in small-screen display) the resulting overlap makes the total image appear smooth.

About the only thing that the casual viewer can do to reduce the halation effect is to adjust the TV receiver brightness and contrast controls downward until the picture clears up. Unfortunately, the payment to be made for this is a dimmer-than-usual picture.

Obviously, the small screen makes for a much smoother image when playing games. However, the smooth images do not help alphanumerics, making the small screen a little difficult to use. So, you pay your money and makes your choice. ♦

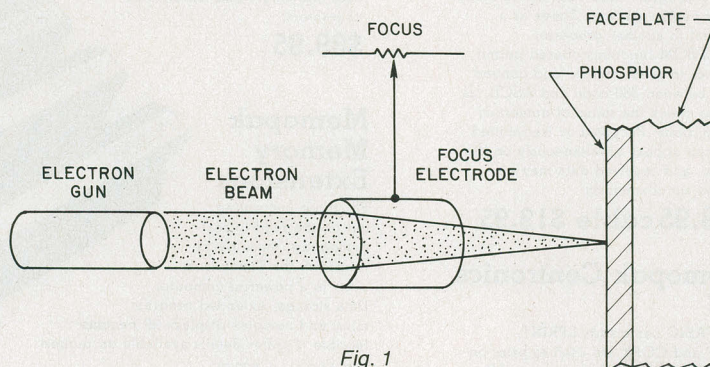


Fig. 1

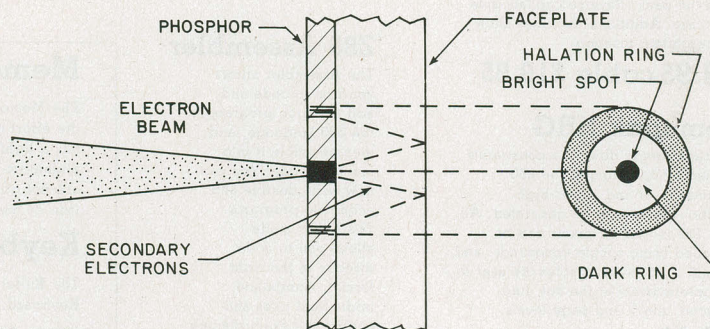


Fig. 2

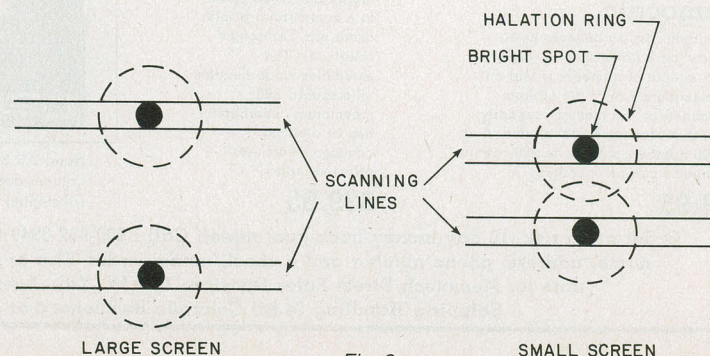


Fig. 3



## Stereo TV— Is There a Better Way?

By Len Feldman

**A**CCORDING to the timetable of the industry committee set up to study and test the three different systems for stereo audio on TV, we might have expected a decision by now. Unfortunately, things don't always go as planned. One of the three contenders made a significant change in its proposed system *after* the lab and on-the-air tests were completed. A second contender, whose own system had not been tested in all its possible configurations, threatened to bring legal action against the first contender if the committee vot-

ed for the "untested" version of the first system. So, instead of making a decision, the committee decided to go "back to the drawing board" or, in its words, "complete the record." This is expected to take several more months of testing and talking.

**A Fourth System.** Meanwhile, from an unexpected source, a totally different approach to stereo TV has been demonstrated. At the recent conference of the Society of Motion Picture and Television Engineers (SMPTE) in New York City, Grumman Aerospace Corp. demonstrated a unique new method of broadcasting stereo audio for television. The system is called "Rainbow Sound." It is an outgrowth of a Grumman product called "Sync Proc" which, in its original development, had nothing whatever to do with audio. The Grumman Sync Proc color encoder was

developed to support video graphics generation while meeting all the timing requirements and NTSC encoding of R(ed), G(reen), B(lue) graphics output. As shown in Fig. 1, the Grumman Sync Proc system also provided Y (luminance), and I and Q (chroma) outputs from the color encoder so that high-quality graphics can be stored on a standard 1/2" VCR.

What has all this to do with stereo audio for TV? Well, in Grumman's SMPTE demo, they illustrated a method for encoding a channel of audio into a video format, using the very same Sync Proc and color encoder developed for graphics generation (Fig. 2). What happens, in essence, is that samples of the audio signals are routed to the RGB inputs of a standard color encoder, where they are matrixed into NTSC composite form, as shown in Fig. 3. The encoded color frame that results from

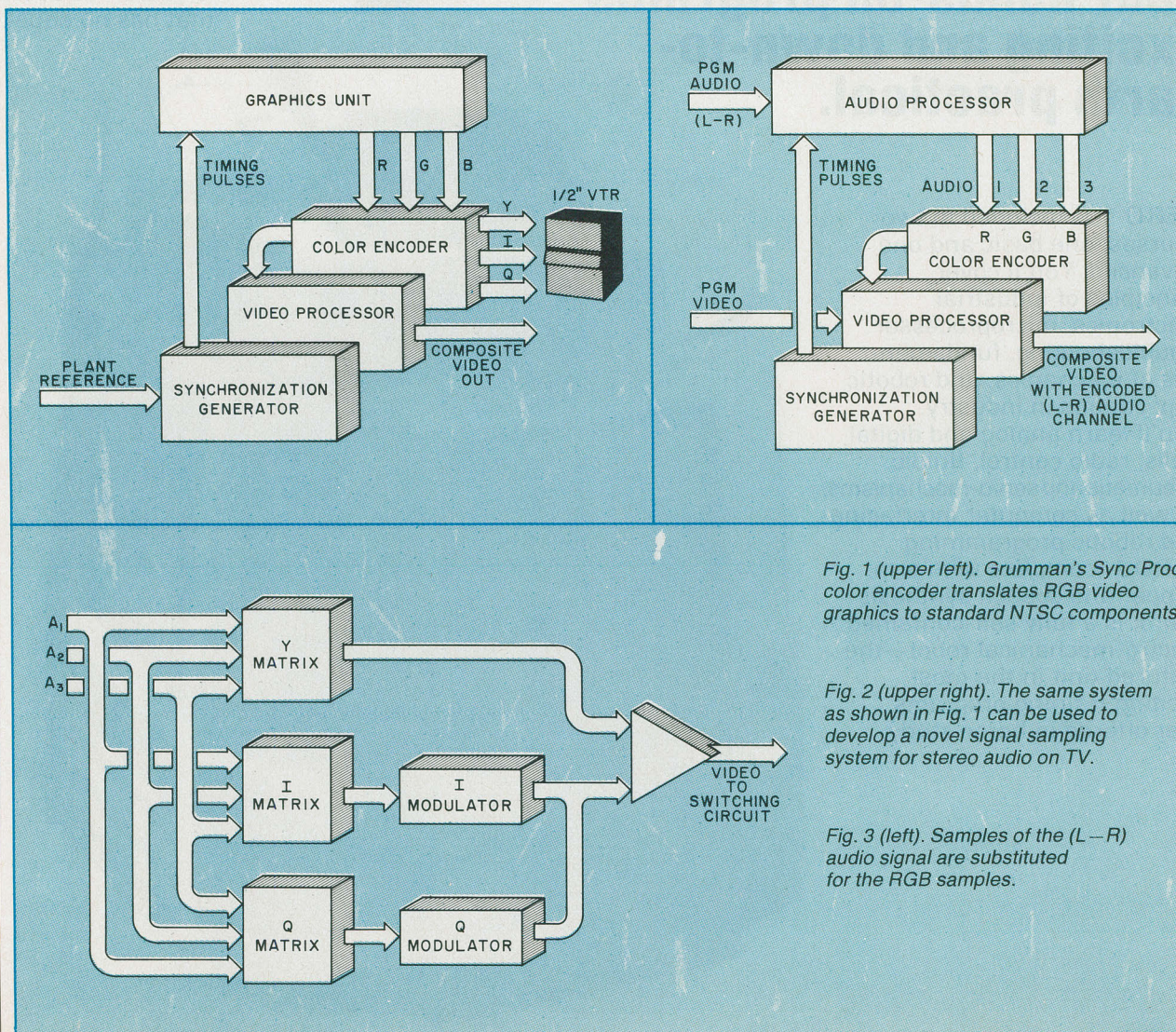


Fig. 1 (upper left). Grumman's Sync Proc color encoder translates RGB video graphics to standard NTSC components.

Fig. 2 (upper right). The same system as shown in Fig. 1 can be used to develop a novel signal sampling system for stereo audio on TV.

Fig. 3 (left). Samples of the (L-R) audio signal are substituted for the RGB samples.



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this process represents a stereo difference signal ( $L - R$ ). Program video and the "color encoded" ( $L - R$ ) audio are joined at the end of each horizontal line of video. This action takes place in the color encoder (Fig. 4) by switching away from program video to the color-encoded audio for 2 microseconds prior to the leading edge of the horizontal sync pulse.

Audio matrixing, or encoding of the left- and right-channel signals, is a well-known technique for maintaining compatibility of monophonic equipment with stereo FM broadcasting. What happens is that the two channel signals are added to form an ( $L + R$ )-compatible monophonic equivalent signal, while the difference between the two audio signals ( $L - R$ ) carries the so-called stereo or spatial information. Such audio encoding is achieved using the simple summing amplifier combinations illustrated in Fig. 5.

Once the ( $L - R$ ) signal has been created, the signal is routed from the audio encoder to three sample-and-hold cir-

cuits (Fig. 6). The time rate for one horizontal line of video within the NTSC format turns out to be 63.5 microseconds. (There are 15,734,264 horizontal lines per second in the standard NTSC color TV system used in the U.S., and the reciprocal of that number works out to 63.5  $\mu$ s per horizontal line.)

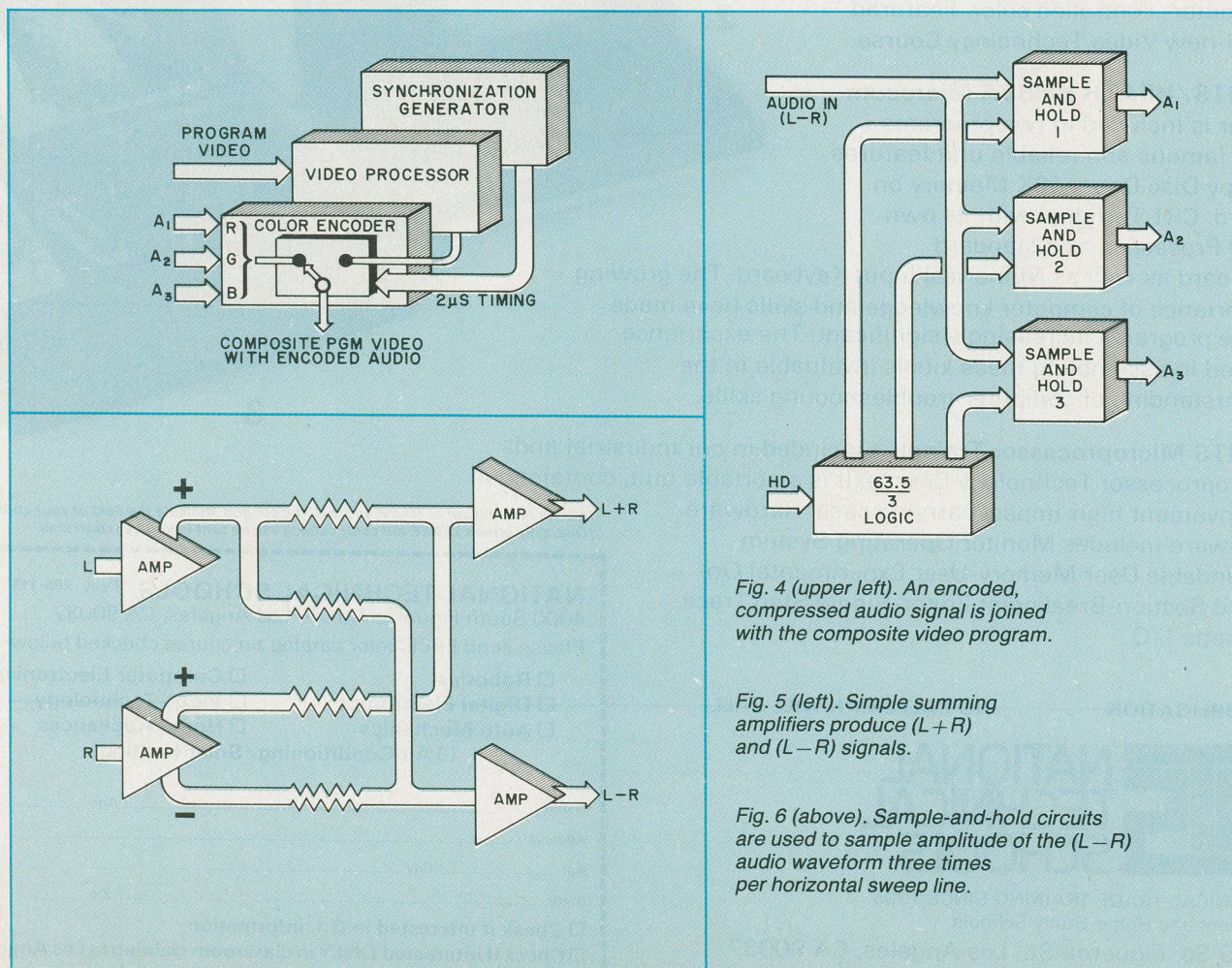
If the audio amplitude is taken three times during the time span of one horizontal line, then we have a sample approximately every 21  $\mu$ s, as shown in Fig. 7. That works out to a sampling rate of approximately 47.2 kHz, or more than enough bandwidth to handle audio frequencies up to 15 kHz, the present legal upper limit for audio on FM and TV. The three samples per line are encoded into the same sort of RGB format that Grumman's color encoder would normally create for separate R, G, and B color-signal inputs, and compressed into a total time span of only 2  $\mu$ s, as illustrated by the line labeled "Encoded Samples" in Fig. 7.

The 2- $\mu$ s encoded audio sample is now switched into the program video in

the 2  $\mu$ s just preceding the leading edge of the horizontal sync pulse (Fig. 8). In effect, the stereo audio ( $L - R$ ) information actually uses up a very small bit of picture time, but it is located at the very end of each horizontal line, an area that is almost always off-screen because TV sets are designed with a certain amount of overscan in the first place.

In its description of this system, Grumman is quick to point out that the value of the audio signal derived from the 2- $\mu$ s sample will only be correct if the settings of luminance gain, chrominance level, and chrominance phase are correct. The system should not be confused with any sort of PCM approach, where signal amplitude errors are of little consequence and variations in pulse width convey information. The Grumman approach might best be described as a PAM (Pulse Amplitude Modulation) scheme.

A block diagram and signal-flow chart of the demonstration conducted by Grumman are given in Fig. 9. Video and stereo audio are fed from a video





disc player to the encoding system, and from there to an r-f modulator whose output is connected directly to the antenna terminals of a TV receiver. The audio information is then decoded and fed to an external stereo audio amplifier and a pair of properly positioned speakers.

A more detailed representation of the encoding process is shown in Fig. 10. Using a video disc as a video and stereo audio program source, the video is processed through a time base corrector (TBC). Left and right stereo signals are converted into sum-and-difference signals. The  $(L + R)$  signal joins the video signal as the primary modulation of the transmitter. The stereo difference signal  $(L - R)$  is processed as described earlier. The program video with the encoded  $(L - R)$ , along with the  $(L + R)$  audio channel, are routed to an r-f modulator and then to the antenna terminals of the TV receiver.

**The Receiving End.** In order to decode the stereo signal in a home TV receiver, the receiver requires some modification. The latter consists primarily of tapping into the horizontal sync signal, the color subcarrier, and the separate Red, Green and Blue feeds (Fig. 11). The monophonic audio channel  $(L + R)$  is broken and brought out of the set for subsequent matrixing with the recovered  $(L - R)$  signal.

The three audio samples recovered from the TV receiver as

individual R, G, and B signals are routed to sample-and-hold circuits. Timing logic derived from the horizontal sync pulse and the color subcarrier provides the necessary timing to restructure the three samples (per line) 21 microseconds apart. The signals are then filtered with a low-pass filter that recreates a continuous audio waveform that is am-

plified as the recovered  $(L - R)$  audio channel. This part of the process is shown in Fig. 12.

The same sort of summing amplifiers that were used to create the separate sum-and-difference audio signals back at the transmitting end are now used to recombine those signals to recreate the original "L" and "R" stereo signals, us-

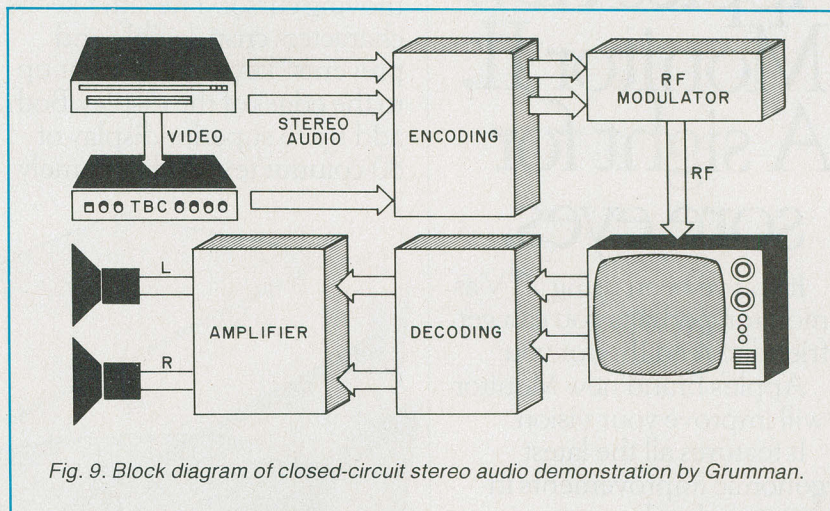


Fig. 9. Block diagram of closed-circuit stereo audio demonstration by Grumman.

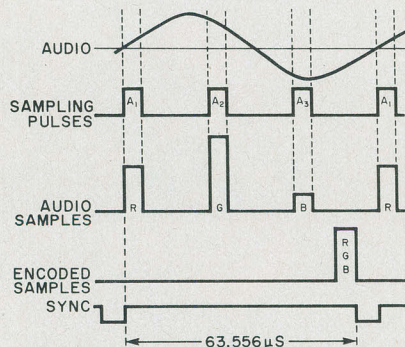


Fig. 7. Audio is sampled three times per horizontal line (bottom) and encoded into a single 2-μs signal.

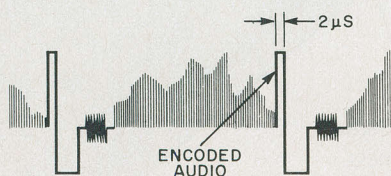
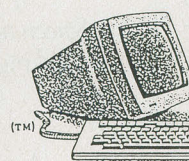


Fig. 8. Encoded audio is inserted at the end of each line of video information.

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# Inside Apple

Vol. 1, No. 3

## Apple's new Monitor II. A sight for sore eyes.

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Studies have shown that the leading cause of eye fatigue for computer users is lack of contrast between the displayed characters and their background.

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And we made that screen antireflective to reduce glare from ambient light.

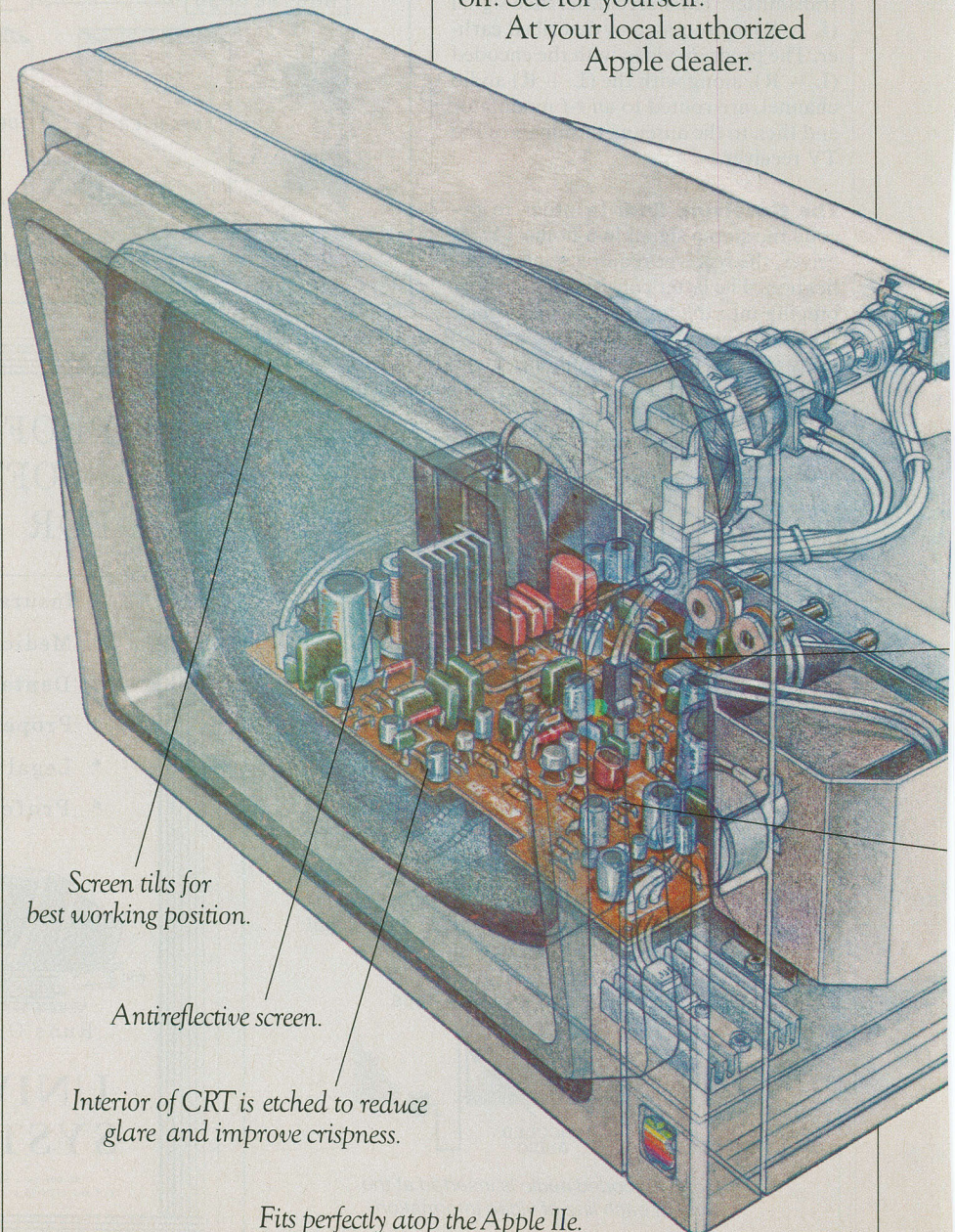
Monitor II also features a high bandwidth video amplifier and a high tolerance linearity circuit. The former keeps characters from smearing

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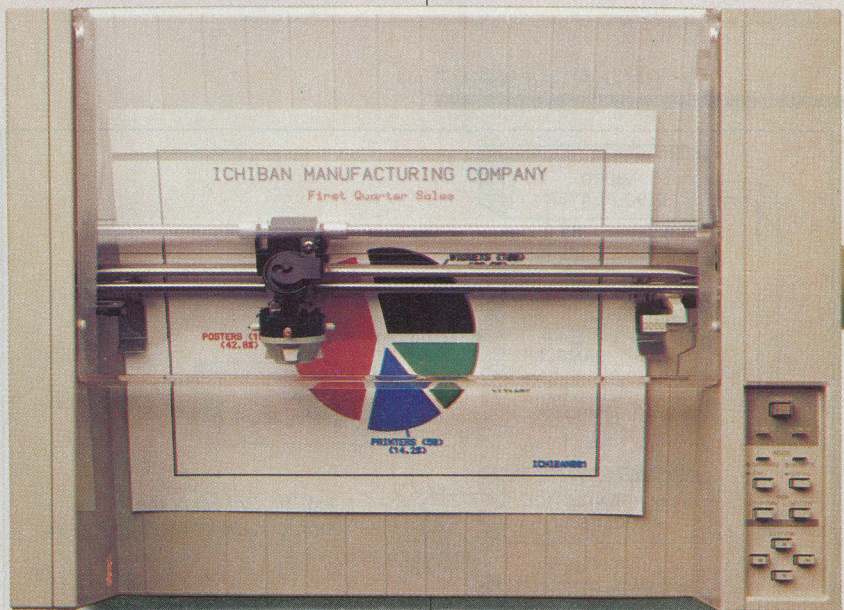
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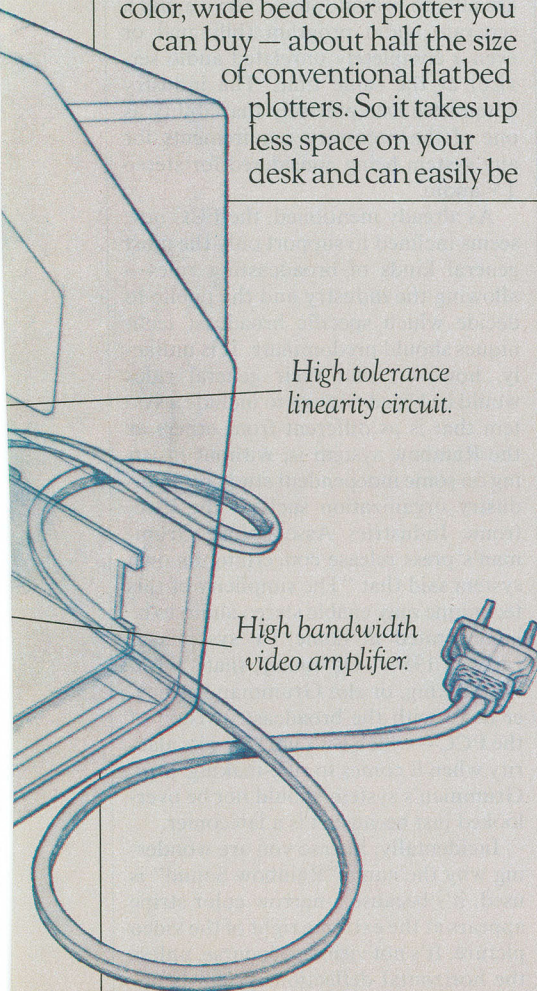


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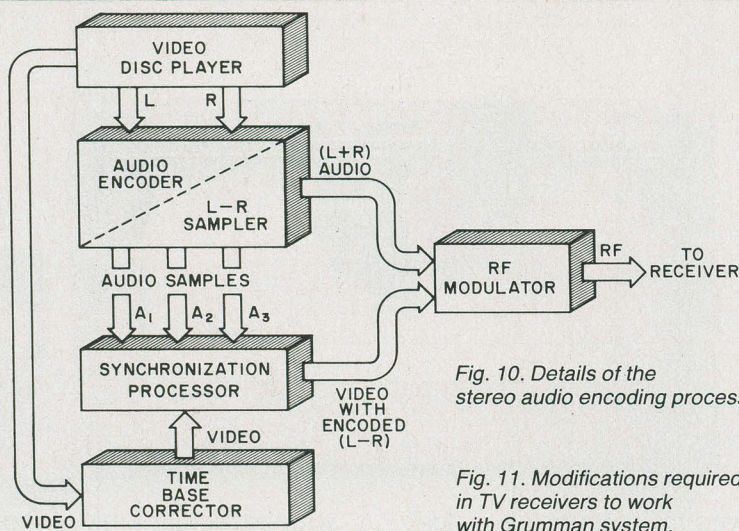


Fig. 10. Details of the stereo audio encoding process.

Fig. 11. Modifications required in TV receivers to work with Grumman system.

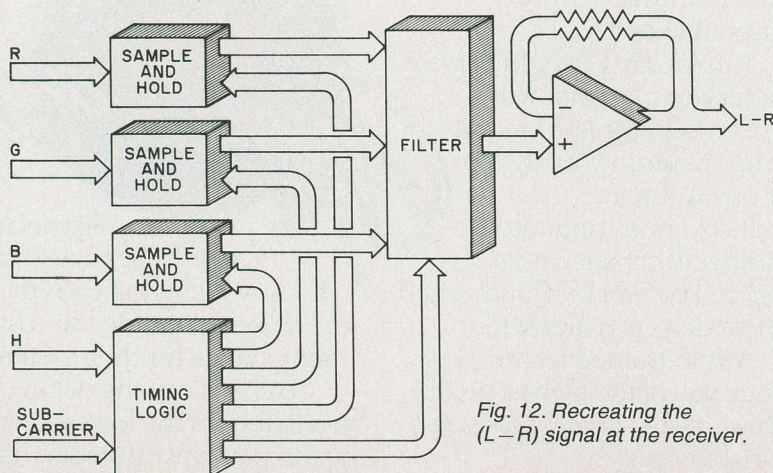
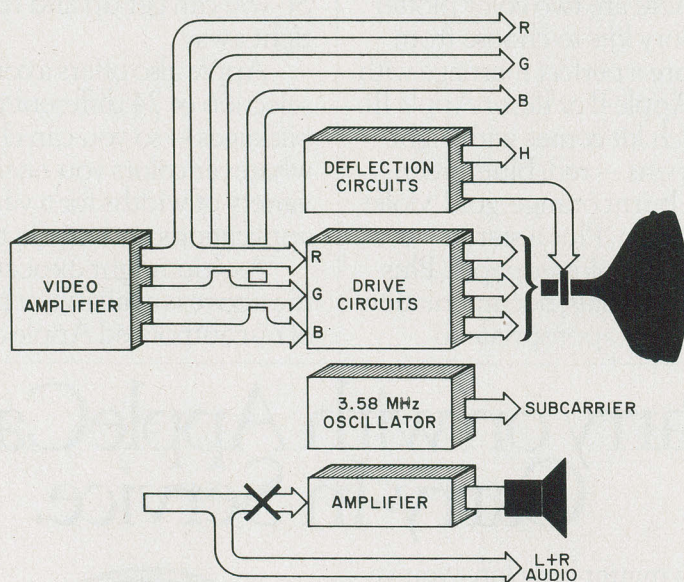


Fig. 12. Recreating the (L-R) signal at the receiver.

ing the familiar algebraic addition and subtraction,  $(L + R) + (L - R) = 2L$  and  $(L + R) - (L - R) = 2R$ . In actual practice, some time delay must be added in the  $(L + R)$  channel to equal the processing delay of the  $(L - R)$  channel.

**What Next for Rainbow Sound?** As simple and clever as this stereo TV audio system seems, there are some practical problems if it is to succeed either as an over-the-air broadcast system or as a cable system. For one thing, it is very late in the game for a fourth challenger to join the list of manufacturers whose systems have been under investigation since 1979.

In addition, while the Rainbow Sound system could certainly be used either for transmitting stereo or a second language, it seems clear from Grumman's description that both of these services could not be implemented simultaneously by a single station. Yet the three other systems now under consideration for multi-channel TV audio are able to provide stereo service *and* a separate audio program (bilingual or even a completely unrelated audio service) at the same time. The industry committee lists precisely that ability as one of the necessary requirements for any system being considered for stereo TV audio.

As already mentioned, the FCC now seems inclined to support only the most general kinds of broadcasting rules—allowing the industry and the public to decide which specific broadcast techniques should predominate. It is unlikely, however, that their general rules would be broad enough to include a system that is as different from others as the Rainbow system is, without insisting on some independent study by an industry organization such as the Electronic Industries Association. Grumman's press release concerning its own system said that "The simplicity of this technique may enable stereo audio to be incorporated in home TV systems as early as 1984." Obviously, that's wishful thinking, or else Grumman has never dealt with the broadcast division of the FCC—which isn't noted for its alacrity when it comes to rule-making. Still, Grumman's system should not be overlooked just because it is a latecomer.

Incidentally, in case you are wondering why the name "Rainbow Sound" is used, it's because a narrow color stripe appears at the extreme right of the video picture. It's not visible, of course, unless the horizontal deflection system is unable to sweep fully across the screen. ◇



# BREAKING THE 40-COLUMN BARRIER

*The difference between a TV receiver and a video monitor for computer use*  
By Leslie Solomon

WHY is it that some computers, like those of the Apple II family, and the Commodore and Atari computers, can display their outputs on the screen of ordinary TV sets, while others will not give satisfactory results without the use of a special video monitor? What makes a monitor different from a TV receiver, and when should you use one or the other? What should you look for in buying a monitor? In this article, we'll try to answer these and other questions about video displays.

Some computers, like the Heath/Zenith H/Z-89, have their own built-in displays. Most, though, require an external means of displaying the data they output in video form. Computers used in offices and scientific installations frequently combine an input device (keyboard) with an output device (monitor) in a piece of equipment known as a terminal. Many home and personal computers, however, rely on a separate unit just for display—either a TV receiver or a video monitor.

Depending on the capabilities of the computer, the display it uses can be either monochrome (black-and-white, -green, or -amber) or color. Knowing how information from a computer gets onto the screen of the display will help you understand the differences between a TV receiver and a video monitor.

No matter what type of video display is used, character generation begins inside the computer with an integrated circuit called a ROM (Read Only Memory). Each character that the computer is capable of producing is stored in the

ROM as an array, or matrix, of bits, each of which represents a dot (bright spot) or "undot" (dark spot or absence of a dot) that makes up a portion of the dot-matrix character that will be displayed on the video screen (Fig. 1).

ROM character generators use a variety of dot matrices, ranging from  $5 \times 7$  (a 35-dot matrix five dots wide by seven

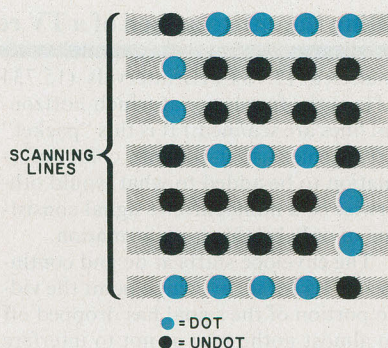


Fig. 1. How a dot-matrix character is displayed on screen.

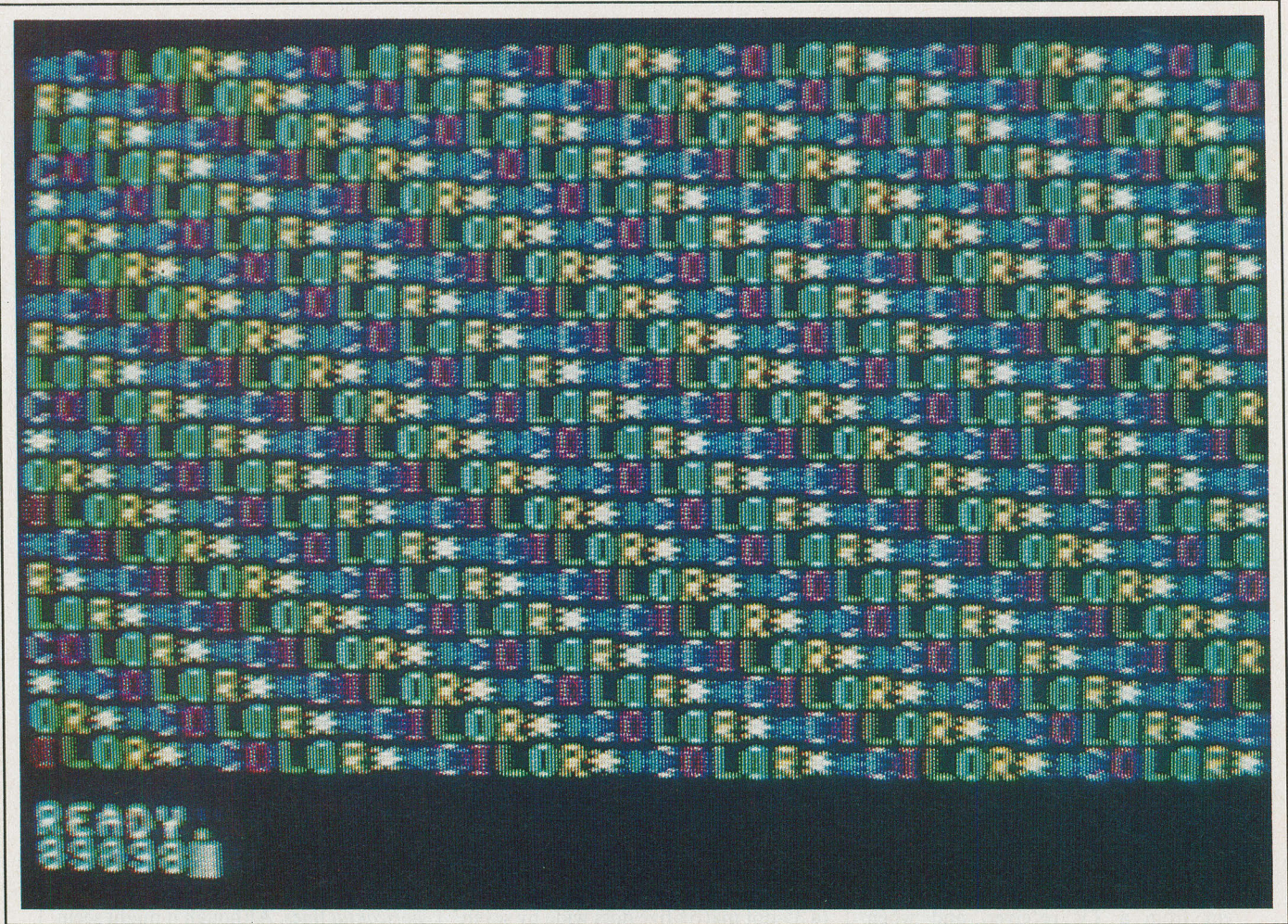
dots high) to a very dense  $17 \times 19$  (323 dots). The greater the number of dots in the array, the better the appearance of the displayed character. The least dense ( $5 \times 7$ ) dot matrix does not allow for proper descenders on lower-case letters. (Descenders are the parts of the letters that extend "below the line." Examples of letters with descenders are j, p, and y.) The most common dot-matrix used—one that has a happy combination of good-looking characters with a reasonable number of dots—is the  $7 \times 9$  array. It affords an 80% greater resolution than a  $5 \times 7$  array.

**Resolution.** The term resolution refers to how sharply an image can be defined on the screen of a CRT (Cathode Ray Tube or picture tube to those of you using TV sets).

In video, there are both vertical and horizontal resolutions. Vertical resolution is the ability of the system to resolve horizontal lines. Although it might seem logical to assume that the 525-line raster used in our television system would yield 525 lines of vertical resolution, this is not so. Resolution in video is not the same as resolution in photography. For example, four black lines separated by three white lines of equal thickness would be defined as four lines of resolution in photography. In video, all the lines are counted, which means that, in this case, we would have seven lines of resolution.

In video, the diameter of the electron beam used in the CRT must be considered, since it forms the "brush" that "paints" the image on-screen. The relationship between that diameter and the width of the line that is "painted" on the screen is called the *Kell factor*, which is optimally 0.7. To find the vertical resolution of any video system, therefore, simply multiply the number of scan lines by 0.7. For example, if there are 260 scan lines, the vertical resolution is a maximum of 182 lines. In conventional TV using 525 lines, the Kell factor indicates that the maximum resolution of the viewed image will be 343 lines. That takes into account the lines lost in the vertical blanking interval, that black bar you see when the picture on the screen "rolls."





On this page is a four-color display filling the entire screen of a TV receiver. Opposite is the same display

Horizontal resolution is related to bandwidth, a subject we'll get to shortly. It is defined as the ability of the system to resolve *vertical* lines. The horizontal resolution of a system can be calculated by multiplying the bandwidth by the active scan time, and then multiplying that result by two. For example, if we assume a 4-MHz bandwidth and a 40- $\mu$ s active scan time per horizontal line, the horizontal resolution will be  $(4,000,000 \times 0.00004) \times 2$ , or 320 lines. Horizontal resolution is the figure you'll usually see quoted by the manufacturer of a display device. As a rule of thumb, you can assume about 80 lines of resolution (*not* 80 characters!) for each MHz of bandwidth.

Thus, all references to 525 (or more) lines of horizontal or vertical resolution on a standard TV receiver should be taken with something more than a grain of salt.

**Bandwidth.** Figure 2 illustrates the envelope bandwidth of an ideal TV signal. It should be noted that what appears to be a smooth curve line is actually a tightly packed series of bursts of infor-

mation at 15.734-kHz intervals. (15.734 kHz is the frequency at which horizontal lines are scanned.) It is this "packet" arrangement that permits color information to be added to what would otherwise be a monochrome signal consisting of only brightness information.

The envelope starts at dc and continues to 4.5 MHz, by which point the video portion of the signal has dropped off to almost nothing so as not to interfere with the audio portion, which is located 4.5 MHz above the start of the envelope. If the audio and video signals were to mix, or intermodulate, the result would be a series of wavy lines called "herringbones," along with other sound-related

distortions that would cause the picture quality to vary according to the sound or music that accompanied it. This can be simulated in a properly working TV receiver by turning off the afc and mistuning the channel selector slightly.

In reality, the bandwidth drops to the 3-dB point, where it is half its original strength, at 4.2 MHz. Actually, the usable video bandwidth of even a good black-and-white TV receiver is no more than 3.8 MHz. In a TV receiver, the bandwidth limitations are the result of more than just the video amplifier stages. Keep in mind that every stage between the antenna terminals and the CRT makes its own contribution to restricting bandwidth if it has been poorly aligned or has drifted out of alignment. Furthermore, if a signal enters through the antenna terminals, that means that the video was first superimposed on an r-f carrier, and later demodulated (separated from the carrier). This is also cause for image degradation.

The image is formed on a CRT screen by a series of lines that are scanned from left to right and from top to bottom, as illustrated in Fig. 3. Thirty frames (full

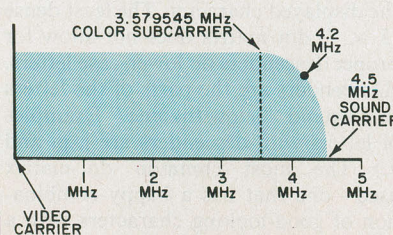


Fig. 2. Envelope bandwidth of an ideal television signal.





on a video monitor. For such things as word processing, the difference in readability is obvious.

images) per second are formed, each made up of two fields. Therefore, there are 60 fields of  $262\frac{1}{2}$  lines in every second's worth of 525-line frames. Ideally, the two fields are interlaced so that the lines of one fall between the lines of the other. In practice, this is rarely the case; true interlace is hard to find. Each horizontal line is scanned at the rate of 15,734.264 Hz. Converting frequency to time ( $1/F$ ) gives us approximately 60  $\mu$ s per active line across the screen.

That figure is reduced somewhat by several factors. First, for reasons of economy, the tolerances of the components used in off-the-shelf TV receivers are not very tight. To make certain that your picture is not smaller than the size of the face of the CRT (which could happen if certain components were far enough away from the proper value) and because, by a fortunate coincidence, most TV action takes place at the center of the screen, manufacturers resort to what's known as "overscan." That is, the picture is made slightly larger than the display area so that the screen will be full no matter what the values (within reasonable limits) of the components

determining the picture size are. To account for this, we have to subtract about 5  $\mu$ s worth of raster from each end of each horizontal line, leaving at most 50  $\mu$ s of usable trace.

To make things worse, since the picture displayed at the center of the CRT is sharper than that at its edges and corners, most computers blank the sides (and top and bottom) of the display they produce. That subtracts a few microseconds more from the time allotted to each active display line (now you know where the term "active" comes from). We are eventually left with about 40  $\mu$ s of active display time per line.

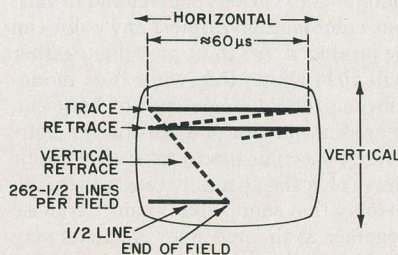


Fig. 3. How the image is formed on a CRT screen by scanned lines.

With all that under our belts, we can now determine how many characters per line can be resolved for a given bandwidth.

Let's assume that we want to display 80 characters on one line. That means that we are allowed, in round figures, 0.5  $\mu$ s per character (40  $\mu$ s/80). With a  $7 \times 9$  dot-matrix character generator, the maximum width of one of the up-to-nine lines making up the character would be seven dots plus two dark "undots" to produce the space between adjacent characters. We would thus have to display nine dots in 0.5  $\mu$ s, 18 dots in one  $\mu$ s, or 18,000,000 dots in a full second.

The video bandwidth required can be closely estimated by dividing the latter number (18,000,000) by two. Thus, for an 80-column line of  $7 \times 9$ -matrix characters, the bandwidth required would be  $18,000,000/2$ , or 9 MHz! As we've seen, that's far greater than what's available from any conventional receiver. A 64-column display would require a bandwidth of 7.5 MHz and even a 40-column one 4.5 MHz.

If we were to generate a  $5 \times 7$  charac-



ter set, with each character having two "undots" to allow for horizontal spacing, things would get a little better, but not much. Each character would require 1.25  $\mu$ s per line to display. An 80-column display would require a monitor with a 5.6-MHz bandwidth, and a 64-column display one with a bandwidth of 4.48 MHz. It is only when we reduce the number of characters per line to 40 or fewer that we enter territory that can be handled by a TV set. A 40-column display of  $5 \times 7$  characters can be managed with a bandwidth of only 2.8 MHz, well within the capabilities of a standard TV receiver, and a 32-column display needs only 2.24 MHz. A nomograph showing the relationship between bandwidth and characters-per-line appears in Fig. 4.

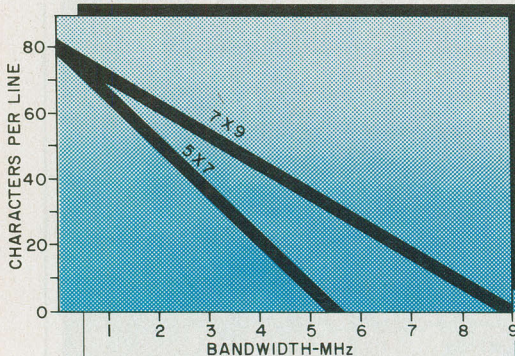


Fig. 4. How bandwidth and characters per line are related.

There are several other factors that limit the number of characters that can be displayed on an ordinary TV screen. As was mentioned earlier, a single 525-line video frame is made up of two fields of  $262\frac{1}{2}$  lines each. Ideally, the two fields are interlaced; that is, the lines of one fall between the lines of the other.

Unfortunately, not all computers can deliver an interlaced 525-line raster, and not all TV receivers are adequate to display a two-field, fully interlaced 525-line raster. This has led to the widespread use of a non-interlaced raster consisting of 260 (or so) horizontal lines.

Now, if  $5 \times 7$  characters are being generated by the computer, each character requires seven horizontal scan lines to display its full height. To allow for the spaces between lines and, in some cases, to allow for an underline-type cursor, at least 10 or 12 raster lines per character are used. If, therefore, only 260 scan lines are available, only 16 to 20 lines of characters can be displayed.

And that explains to a great extent why you can't use your TV set to get a good sharp 64- or 80-column display. It's like the farmer trying to put ten pounds of fertilizer into a five-pound

sack. To do the display justice, you need a monitor that can comfortably accept all the video information fed to it.

**Color.** So far, we've restricted our discussion of the limitations of TV sets as display devices to monochrome. What about color?

The NTSC system used in this country for transmitting color leaves a lot to be desired. If you are old enough, you can remember the early days of green faces and purple bananas. The chroma, or color, information is carried on a 3.579545-MHz subcarrier that is quadrature modulated. That is, it uses phase shifting to transmit color information. In fact, the tint control on a color TV is a phase changer; and, if you make even a small adjustment of that control, you'll see how the colors change. A change in phase relationship of only three or four electrical degrees can make things appear noticeably different.

Color is of relatively low importance in the scheme of our TV system because it was "squeezed into" an already existing monochrome system.

The same bandwidth restrictions that hamper monochrome TVs also apply to color receivers, but there are a few more of them. In color receivers, there is a trap at 3.579 MHz to take out the color-burst signal that carries the chroma information, and another at 920 kHz to remove the beat frequency that results from the mixing of the 4.5-MHz audio carrier and the 3.579-MHz color burst signal ( $4.50 - 3.58 = 0.920$ ). Each trap removes some video information and therefore causes the display quality to deteriorate. Color displays also present several additional resolution problems unique to them.

Our previous discussion of resolution was based on a monochrome display. The phosphor coating on the screen of a monochrome CRT is solid; wherever the electron beam hits, it will strike some phosphor material and cause it to glow. If you have ever looked closely at the face of a color CRT, you know that it is very different. It is coated with an array of phosphor dots or stripes.

Three sets of phosphors are used: red, green, and blue. By exciting these phosphors to various degrees and in various combinations, almost any color can be produced. All three glowing together will yield white. But, while on a monochrome tube a single spot of light can represent one dot of a dot-matrix character, on a color tube it takes three color dots (plus the spaces between them) to display that same white point. As close together as the phosphor elements may be, they will not be able to resolve as small, or as sharp, a point as could be obtained on a monochrome screen.

The space between the phosphor dots is referred to as pitch. A color monitor with a fairly high resolution may have a CRT with a pitch in the neighborhood of 0.31 to 0.43 mm. In contrast, the pitch for a CRT used in a home TV receiver may be well in excess of one mm. The smaller the pitch, the greater the number of phosphor elements, and the more detail that can be presented.

Another factor that can affect the resolution of a color display is convergence—how accurately the electron beams (one for each color phosphor) strike the phosphor elements they're intended to strike. Convergence is adjusted by the use of small adjustable permanent and electro-magnets, which force the three electron guns to converge their electron beams at the same three-phosphor point on the shadow mask of the CRT (Fig. 5).

The colors from a properly converged CRT will be true and clean. If the convergence is somewhat off—even slightly—the electron beams can strike more than one phosphor dot or stripe, producing a smeared image regardless of the quality of the rest of the system.

The convergence quality of a color TV receiver or video monitor can be observed by carefully examining a portion of the displayed image and looking for color fringes around some areas. If a ring is present, the convergence should be touched up by a qualified technician. If the chroma (color) control is turned

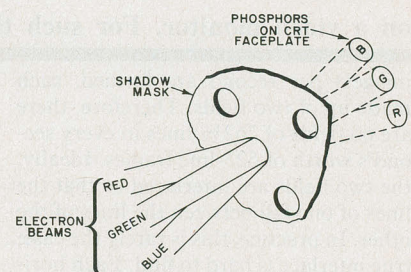


Fig. 5. Electronic beams are converged at one point on shadow mask.

all the way down while a color image is being displayed, the result should be a clean monochrome with no fringes.

**RGB Monitors.** There are several ways of getting a color signal into a color monitor. Monochrome and some color monitors accept a composite video signal, which is what is generated by most video games, closed-circuit TV cameras, and (of course) computers that have a direct-video output. That signal conforms to the NTSC standards used in broadcast television. The luminance (brightness), chroma (color), and sync information are all combined into one signal.

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proach differs in that each of the three color signals has its own independent channel. The sync signal may be separate or, in some systems, may ride on one of the color signals (usually the green). Most computers require a special board to generate an RGB signal.

The major advantage of RGB is that, since the color signals are not demodulated by a set of synchronous demodulators with their attendant phase and gain problems, the quality of the color image is much better than that of one generated using the composite-video approach. Phase and gain variations are the principal enemies of the NTSC color system, and they do not exist in RGB.

There are actually two different types of RGB systems. One is analog, where the level of each color signal can be varied continuously to yield a near-infinite range of brightness levels and colors. The other system uses TTL logic-level signals to drive the electron guns, where each electron beam is either on or off. Excluding the sync signal, this can be done with three bits to generate eight colors (including white and black).

**Other Factors.** One of the most common complaints heard in computer stores has to do with the relatively high cost of video monitors. Since most people (at least those who haven't read this article) still think that a video monitor is a conventional TV receiver without the tuner and i-f strip, they feel that the price of the monitor should be less than that of a TV receiver.

With some low-cost monochrome monitors, this is actually the case since they are indeed "unfinished" TV receivers. However, it must be pointed out that these monitors, which usually incorporate a 4.5-MHz sound channel, also have the minimal video bandwidth of a TV receiver. You gain very little by using such a monitor.

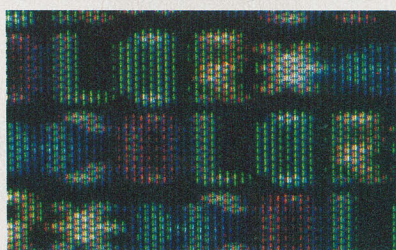
A true video monitor is one that was designed from the start to be a video monitor. Its bandwidth is higher, its sweep linearity is better, and its convergence and phosphor pattern (in the case of a color system) are better. If the monitor has an audio input, it is usually for baseband audio, and the sound does not affect the video signal in any way.

Obviously, superior design means superior components, and that increases costs. Some video monitors have such excellent specifications that their cost can be in the thousand-dollar region.

Price is usually a function of CRT size and system bandwidth because the larger CRTs are more expensive, require larger video and sweep drive signals, and are more prone to misconvergence and other nonlinearities. These latter elements mean that a better-quality-

ty-controlled (more expensive) sweep system is required. Increased bandwidth usually means more stages of amplification, which also ups the price.

Some monitors and TV receivers have rather tight constraints on the sync and video signals they will accept. Many computers generate video signals that are slightly different from those considered to be standard. If your computer is one of them, you might experience a problem in obtaining proper horizontal or vertical sync, or the best contrast or color. In many cases, older TV receivers (which had looser tolerances) produce more stable images than those of recent manufacture.



### Resolution is especially critical on color displays.

**What to Look for.** By now you should have a good idea of what sort of display device—TV receiver or video monitor—is best for your computer and purposes. How do you go about choosing the right one?

Before buying any video monitor or TV receiver, be sure that it will work to your satisfaction with the computer you have. There are a couple of tests that you can make.

With the computer and monitor (or receiver) connected and powered up, type a screenful of lower-case m's. This letter is formed from three short vertical lines connected at the top. Note that each of those lines is formed from a bright dot, a dark "undot," and another bright dot. When the letters are typed side-by-side (mmm . . . mmm) they represent close to the maximum number of pixels (dots) that the computer can generate for display on one line.

If the display has good bandwidth, then each individual "m" across a line will be clear and distinct, with no trace of blurriness or smear. (Actually, a *little* horizontal smear can be a good thing; it

makes the characters look more "solid." There should be no smear between characters, though.) Note also that each line of characters should be straight across the screen, with no bowing or bending in the middle. Also, the lines should be straight up and down at the sides. If either of these two types of distortion is noticed, the CRT's sweep linearity needs to be corrected. If the upper few horizontal lines are "ragged" at their extremes, then the horizontal sync is at fault and needs looking after. The display should not jitter or flicker.

If your computer is capable of generating color, use the color commands in its BASIC to generate a simple color display and use it, in conjunction with the chroma and tint controls on the monitor or receiver, to check the quality of the display. What you see should be close to what's described in your computer's manual. Resolution is especially critical on color displays.

Check the range of focus, brightness, and contrast available. The focus (the control may be inside the video device) should be adjustable to either side of optimum. The brightness and contrast should be adequate for the conditions under which you will be viewing the display and the image should not degrade noticeably when the contrast is turned fully up. A good video monitor will have provisions for adjusting the level of the input signal to compensate for the different video levels available from different computers.

Do not choose a screen that is too small since that will probably force you to squint to make out the characters. In most cases, an 11" or 13" screen is the smallest you should consider. A 25" color TV is great for games, provided you don't watch it from too close up.

Note that a lower-priced monochrome monitor will invariably produce a better image than a more expensive color monitor. This is due to the effects of convergence, color separation, and the limited bandwidth available. However, color can make a tremendous contribution to most software, and can be the lifeblood of games.

If you've read this far, it should be apparent why a conventional TV receiver cannot give the results that can be obtained from a video monitor. The problems that arise from resolution and bandwidth restrictions are barely noticeable when playing games in color, or when watching TV programs or movies, since the color, sound, and action take your mind off the relatively poor display. When you start using a computer, though, and really start concentrating on what's on the screen, you'll quickly realize the value of a broadband video monitor. ◇



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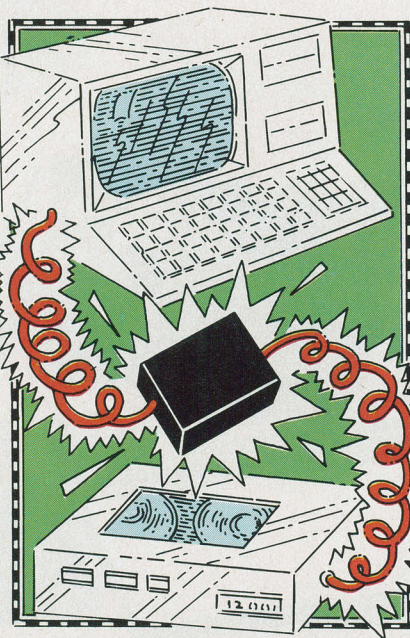
**W**HEN connected between a TRS-80 and its associated cassette recorder, the Cassette Control Box described here performs all the required interfacing to help produce better tape loading, saves wear and tear on the computer's internal reed relay, and provides an audio output for use in sound effects programming. The circuit is shown in Fig. 1.

The plug that normally goes to the cassette recorder EAR jack is connected to *J1*, with *P1* connected to the cassette EAR connector. Switch *S1* is closed when loading a tape and opened when saving a program. This will keep extraneous electrical noise (mostly hum) from reaching the recorder.

The slender ( $\frac{3}{32}$ " ) grey connector that conventionally goes to the cassette recorder power control input is now connected to *J3*. Within the TRS-80, this line comes from a low-power reed relay whose contacts are power limited and can be fused under certain loading conditions.

*Do not* use the internal reed relay as a sound-effect device. Avoid any program

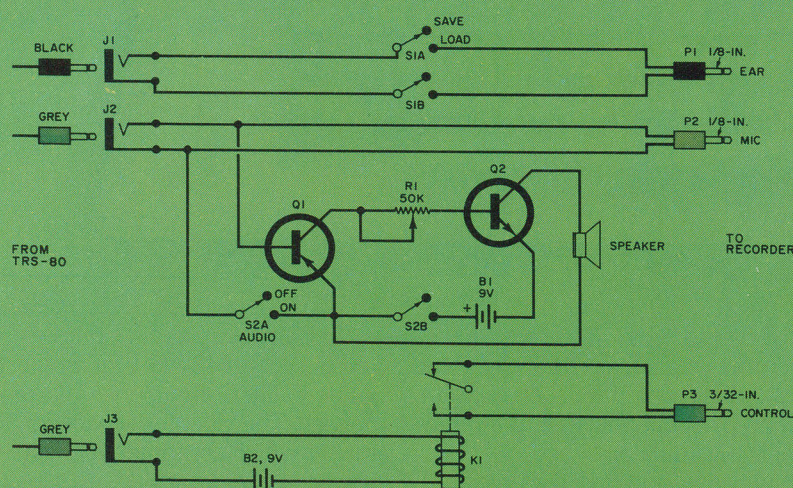
lines such as FOR X = 1 TO 10: OUT 255,4: OUT 255,0: NEXT. This will cause a buzz at the top right-hand cor-



ner of the TRS-80. Run the above line *once* to hear this sound then *never* use it again. In the Control Box, this output drives a higher-power relay *K1*, which in turn, can be used to control higher-power external devices. The contact rating of *K1* is contingent on the load. The contacts of the relay that is called for in the Parts List can handle up to 1 ampere.

The TRS-80 line that normally goes to the cassette recorder MIC input is connected to *J2* and directly coupled to *P2*, which is now connected to the cassette MIC connector. The two-transistor circuit (*Q1* and *Q2*) is switched into this line when *S2* is closed. In this mode, signals fed to the MIC line can be heard. This circuit is used for sound effects programming. Any pnp silicon transistor can be used for *Q1*, and any npn silicon transistor can be used for *Q2*. Potentiometer *R1* serves as a volume control.

The three circuits can be mounted within a small metal enclosure with all connectors and switches suitably identified.



*The three circuits operate independently between cassette and computer.*

## PARTS LIST

- B1,B2—9-V battery and holder
- J1,J2— $\frac{1}{8}$ " minijack (Radio Shack 274-333 or similar)
- J3— $\frac{3}{32}$ " mini jack (Radio Shack 274-292 or similar)
- K1—9-volt relay (Radio Shack 275-004 or similar)
- P1,P2— $\frac{1}{8}$ " mini plugs (Radio Shack 274-286 or similar)
- P3— $\frac{3}{32}$ " mini plug (Radio Shack 274-289 or 291 or similar)
- Q1—Pnp silicon transistor
- Q2—Nnn silicon transistor
- R1—50 kilohm potentiometer
- SPKR—8 ohm speaker
- S1,S2—Dpdt switch
- Misc.—Suitable enclosure, cable, mounting hardware, press-on type, etc.



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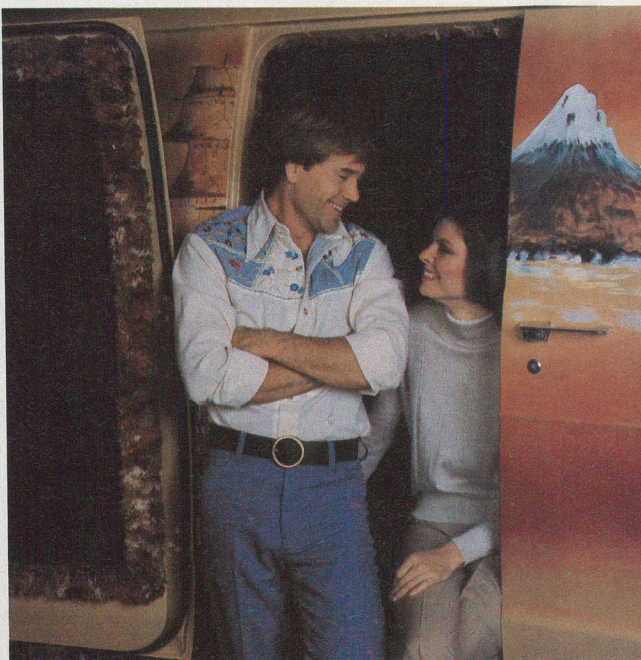
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*The Workslate—a lap-size workstation with a big LCD and much more*  
By Joe Desposito





## THE WORKSLATE

IT was inevitable that someone would create a lap-size portable computer with built-in spreadsheet software. The surprise, though, is how it was done. The product, called Workslate, is not your standard microcomputer. Designed by California-based Convergent Technologies, Inc. with the non-computerist business person in mind, Workslate uses an extensive series of menus, selected with "action" keys, to achieve results. Other keys, such as the DO IT key that is actually an "enter" key, enforce its non-computerist image. In fact, this computer doesn't even include BASIC!

Workslate's standard features are impressive: a 46-character by 16-line liquid-crystal display; a keyboard and keypad; a 300-baud modem; a telephone amplifier; a microcassette for data storage and audio recording; three built-in worksheets called Memo Pad, Phone List, and Calendar; a real-time clock and alarm; blank ready-to-go spreadsheets; and a simple but powerful spreadsheet programming language.

Workslate's design looks like something out of a Pierre Cardin collection. A black plastic case is decorated with green, white, and yellow words and letters, a large display, and gray keys (except for a single green one) in assorted geometric shapes. The computer, or should I say personal business workstation, measures  $8\frac{1}{2}" \times 11\frac{1}{4}" \times 1"$  (about the size of half a ream of typing paper) and weighs just under  $3\frac{1}{2}$  lb. Power is supplied by four AA alkaline batteries or an ac adapter. The suggested retail price of the unit is \$895.

**A Tale of Two Worksheets.** Before we get into the nitty gritty of the Workslate's features let's talk about a couple of ways that this machine can be used. Suppose you were interested in the performance of certain stocks. You could press the WORKSHEET key, select your "Stocks" worksheet (or whatever name you called it) and review the prices for the last few weeks.

Then you could log on to Dow Jones and have Workslate automatically enter today's prices into your file. At this point, you could decide to buy, sell, or hold based on the formulas that you had entered into the spreadsheet. If you need to call your broker, just have Workslate dial the number automatically, and you can talk to that person via Workslate's telephone amplifier. How's that for some fun?

Or else, you might take Workslate out in the field on a sales call. Of course, your products, prices, quantities, discounts, etc. would all be neatly entered into your "Catalog" worksheet. Then

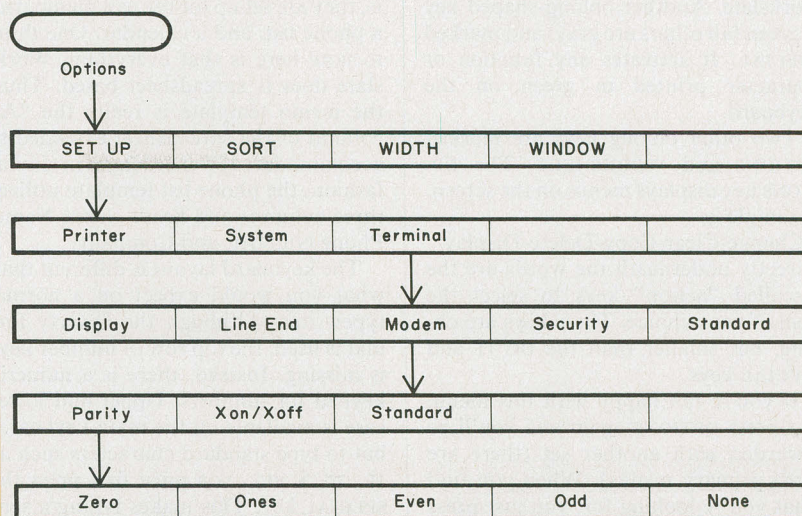


Fig. 1. A sample of Workslate's menu structure.

when you get the inevitable question, "What can you do for me?" it's just a matter of changing a number in one of your formulas and pressing a button to have Workslate calculate a new list of prices for you.

These are just a couple of examples to give you a feel for what Workslate is all about. Now let's examine the machine in more detail.

**The Display's the Thing.** Workslate's display is 42-characters across by 16-lines down. Compared to the most popular lap-size on the block, the Radio Shack Model 100, Workslate displays more than twice the number of characters. However, there's one drawback—the screen isn't twice the size. To fit on the  $3" \times 6"$  screen, Workslate's characters are  $\frac{3}{16}"$  high, which is considerably smaller than the Model 100's. But the characters are completely legible, and there is an adjustment dial at the left side of the unit to make them as readable as possible. The only problem you might encounter with the screen is reflections from overhead fluorescent lights.

The display is divided into four areas, which may or may not be present simultaneously. The top line of the display is the status line, which shows the file name, cell data or formula, % of memo-

ry remaining, date, and time of day. When operations are being performed, a square blinks on and off in the percent memory box. If the modem or phone is in operation, a phone symbol appears in the box before the date. Warning messages such as "Replace back-up batteries" appear here, too.

Just below the status line is the spreadsheet work area which takes up the major portion of the display. It is anywhere from 11 to 15 lines long depending upon what else is being displayed. Two lines from the bottom is a two-line area that is used to give information to the user on the type of input that is expected. This area is where spreadsheet formula information is entered, among other things. The last two lines contain the Workslate's menus. There are five keys, one below each menu item, which are known as the "action" keys.

The screen can display high-resolution graphics as well as text. Graphics symbols are available as a menu item although specific graphics software is not.

**A Key by Any Other Shape.** Circular keys? They can't be serious, I thought, when I first laid eyes on the Workslate. But after typing on them for a while, I realized that they did the job very well. And don't confuse these keys with the "chiclet" keys found on some low-cost computers. They are worlds apart.

There are 60 keys in all, and other shapes besides circles. There's a large diamond-shaped key that is used to advance from cell to cell on a spreadsheet, and an oblong key that says DO IT. So I did it! It's just an "enter" key in disguise, but its name underlines what this

```

=Dial("123-4567",Data)+GoTo(A2)
=Send("CPS")+GoTo(A3)
=WaitFor("ID:") + Delay(1) + GoTo(A4)
=Send(70000,000CR)+GoTo(A5)
=WaitFor("Word:") + GoTo(A6)
=Send("SECRET:WORDCR")
  
```

Fig. 2. Log-on procedure.



## THE WORKSLATE

machine is all about—it's a modern-era workslate. Another oblong-shaped key is green (all others are gray) and marked SPECIAL. It activates any function or character printed in green on the keyboard.

Two other oblong keys are marked OPTIONS and WORKSHEET. The OPTIONS key displays menus on the screen. A sample is:

Change-Clear-Copy-Delete-Display  
Directly underneath the words are the so-called "action" keys to select the item of your choice. These keys are oblong, but smaller than the DO IT and SPECIAL keys.

If you're not happy with this menu, just press OPTIONS again and you'll be rewarded with another set (there are three primary menus). When you find what you're looking for, you just press the corresponding key and a secondary menu is displayed. This continues on for as many as five menus in some cases. However, the average is three.

The WORKSHEET key brings up a menu that shows the files currently stored in memory. A total of five can be stored at any one time. On initial power up, if you press WORKSHEET the menu looks like this: empty-empty-Memo Pad-Phone Lst-Calendar. The three

files listed are actually templates. That is, they are set up for use as a memo pad, a phone list, and a calendar. One thing to note here is that everything Workslate does is spreadsheet based. Thus, the memo template is really the "A" column of the spreadsheet extended to accommodate 128 characters. In similar fashion, the phone list template utilizes three columns and heads them: Name, Phone Number, and Company.

The keyboard layout is different than what you would expect on a normal typewriter. Although the Qwerty format is used, the top row of number keys is missing. Instead, there is a numeric keypad for numbers. Upper and lower case is available on the main keyboard, but to type standard characters such as @, #, \$, etc., you must first press the SPECIAL key. This makes typing a sentence such as "Hi Dad! Send \$\$\$\$." somewhat awkward because you have to shift back and forth from the SHIFT key (only one key, located on the left of the keyboard) to the SPECIAL key, and side to side from the main keyboard to the numeric keypad. But this machine is not really meant for words, it's meant for numbers.

A few other keys that deserve mention are the CANCEL, BACK SP, and FORMULA keys. CANCEL allows you to obliterate any words or numbers that you start and subsequently become disenchanted with. However, since this key is right atop the SHIFT key you may sometimes obliterate when you mean to shift.

The BACK SP key does just what it says—it moves you back a space and cancels any number or letter it meets (destructive backspace). To go forward you would just press the spacebar (a destructive frontspace?). In any case, there is no provision to go back and forth in a non-destructive way while you are in a cell. However, if you choose the CHANGE option, non-destructive moves can be made with the diamond-shaped key.

The FORMULA key is used to place a formula in a cell. When you press it, a directive appears on the screen that states, "Select an action key to Type Formula, then Do It." Beneath this is the start of a formula, for example, Cell D11=. Below this are five choices: Average-Maximum-Minimum-Total-Copy Cell. These can be used in the formula ("Copy Cell" will just copy a formula from one cell to another). To select one of these items, you just press the corresponding key below it. If you want to insert a formula without using one of the options, you just type it in.

Most items on the keyboard are printed in white, green or yellow above and below their respective keys. However,

there are some functions and characters that are hidden. For example, if you want to send a control character you must press the SPECIAL key and hold it down; then you press C and release both keys (they cannot be pressed simultaneously). The next letter pressed will be a control character. Green legends are absent from the middle line of circular keys (except for the last key), but most will print a symbol if you hold down the SPECIAL key. This is where you can find such infamous characters as backslash, underline, and open-single quote, among others.

You may also type graphics characters with Workslate. To do this you just select the Draw option. Fourteen graphics characters are available. Four of them appear on the screen along with the word "more." Selecting "more" gives you access to the rest of them.

What I've said thus far about the keyboard does not exhaust all of its functions, but I'll deal with the remaining ones later.

**To Store or Not to Store.** Sitting about midway up the right-hand side of Workslate is a microcassette tape well. Normally, when one sees this on a computer, storage comes to mind. This is true for Workslate, too, but not completely. The microcassette can also be used for voice recording.

The microcassette records (and plays) on two tracks, one for audio and one for digital. To make an audio recording, you press the SPECIAL and MEMO keys simultaneously and the following menu appears: Record-Play-Stop-Rewind-Forward. You can perform any function on the menu by pressing the key below the corresponding menu item. For example, if you use a dictaphone in your office, you can dictate a letter, pop the microcassette out of the recorder, and hand it to your secretary.

For data storage, you press SPECIAL and SAVE simultaneously. You are then queried as to which worksheet you wish to save. You respond by pressing the key under the corresponding worksheet (which appears in the menu section of the screen) and the worksheet is automatically saved to tape.

The recorder uses a saturated digital technique for storing data. Since the transfer rate is 2400 baud, the operation is fairly fast although not as fast as a disk drive.

To retrieve a worksheet, you press SPECIAL and GET simultaneously. The screen then displays up to five worksheets that are stored on the tape. This, in a sense, is the tape's directory. To load the desired worksheet, you just

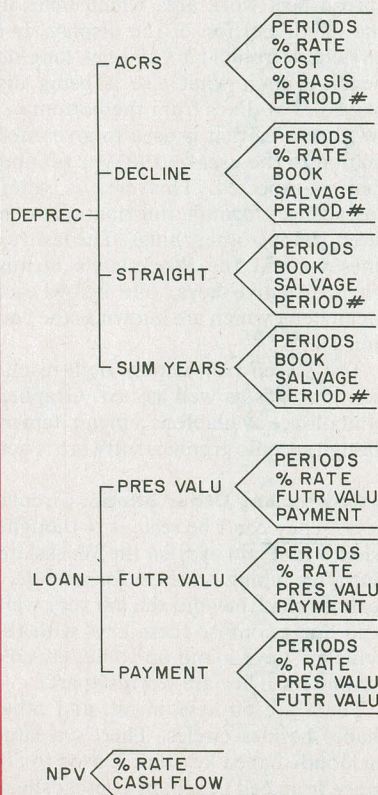


Fig. 3. Financial menu tree.





**Workslate is an ideal tool to take along with you when traveling or making business calls.**

press the key below it. The tape is automatically fast forwarded to the correct spot and loading of the worksheet begins. Thus, it is completely computer controlled.

When storing data, you also have the option of recording an audio message with it. For instance, you might say: "This file contains my expenses for the trip to XYZ, Inc." Then, when you retrieve the worksheet you are given the option of playing back anything you may have recorded. Each microcassette can store up to five worksheets per side or 30 minutes of audio recording.

At the side of Workslate is a volume control to adjust the audio from the speaker. There are also two jacks for a microphone and earphone.

**Reach Out and Touch.** One of the features of Workslate that gives credence to the term "business workstation" is a built-in telephone amplifier. Using this feature in conjunction with the phone list worksheet makes "reaching out" a very simple process. The scenario goes like this. First you press WORKSHEET and select "Phone Lst" from the menu. Then you press SPECIAL and PHONE. A menu appears and you select "Dial." You may dial manually by punching in the number on the numeric keypad. (It is possible to reconfigure the numbers on the keypad to agree with touch-tone

operation through an appropriate menu selection.) However, it is easiest to let Workslate dial automatically. This is done by positioning the cursor in the cell that contains the number you want to call. Now when you select "Dial" and press DO IT, Workslate dials automatically. When you're through talking, or if you get infuriated midway through the call, just press the "Hang Up" option. For those who need it, a provision is made for dialing from a rotary line. To avoid using the SPECIAL and PHONE keys you can save the menu on your phone list worksheet and it will appear when you select the list. Also on the menu is "Receive." This doesn't mean that you can use Workslate as an answering machine, but it will automatically make a phone-receive connection and issue a recorded message to the caller.

Besides voice communications, Workslate is capable of data communications. This is accomplished via a built-in, direct-connect, 300-baud modem and communications software.

To set up parameters for communications, you start at "Set Up" from the primary menu. From this point, there are four levels of menus as shown in Fig. 1. Selecting parity takes eight keypunches if you consider that "Set Up" is the third "Options" menu. Although this is tedious, it is not the usual

procedure with Workslate.

To connect to an information source such as CompuServe, you simply press SPECIAL and PHONE. You are then presented with the phone menu. From this menu, you select "Dial" and enter the number. When the tone is received, the computer automatically shifts into terminal mode. Then you enter the necessary information to log onto the network.

If manual log-on is not your style, you can do it automatically. In fact, the whole operation can be performed automatically, from dial-up to exit. For example, suppose you wanted to call up EMAIL on CompuServe, have it retrieve your mail, and then log off. This can be done using spreadsheet-type commands. An automatic log-on procedure is shown in Fig. 2. Note the spreadsheet commands such as "Dial," "Send," and "Wait For," and the references to spreadsheet cell numbers.

To activate the procedure, you place the cursor at the first cell and then press SPECIAL and DO IT. Also note that carriage returns can (and must) be imbedded in the commands. These are available in the menu structure as further options under "Line Send" shown in Fig. 1.

For those who wish to transfer files from Workslate to a computer such as the IBM PC (or vice versa) a special



## THE WORKSLATE

software package is currently under development for the purpose. It will permit sending spreadsheets between Workslate and either Multiplan, Lotus 1-2-3, or VisiCalc. The software will be available first for the IBM PC. Of course, Workslate-to-Workslate file transfer is supported now.

The phone line is connected to Workslate via a modular jack at the rear. A second modular jack allows you to connect a telephone to Workslate (to make a handset accessible to the user).

Convergent Technologies plans to market a fold-up acoustic modem in the near future. This will enable the modem to be used in hotels and other places where a modular plug is not available.

**The Heart is a Lonely 6303.** Nowadays, many microcomputers include more than one microprocessor to handle different tasks. Workslate uses only the Hitachi 6303 (CMOS version). This is essentially Motorola's 6800 CPU. However, some additional help is provided in the form of two proprietary logic gate arrays that handle the display and microcassette functions.

Included with the system is 64K ROM and 16K RAM. The RAM will be expanded to 32K in the near future as a standard feature, according to a company spokesman, although there will be no expansion packs sold per se.

**A Spreadsheet for All Reasons.** On initial power up, a blank spreadsheet appears to the user. You can begin using it immediately, since commands are either on the keyboard (hard-keys) or in the menu area (action-keys). All that's necessary is to position the cursor in the cell of your choice and type away.

Anytime you want to use a formula, you just hit the FORMULA key and enter it. Workslate can do most of the functions of sophisticated spreadsheets and, in some cases, more. What's even more appealing, as noted before, is that most functions are initiated by selecting them from a menu.

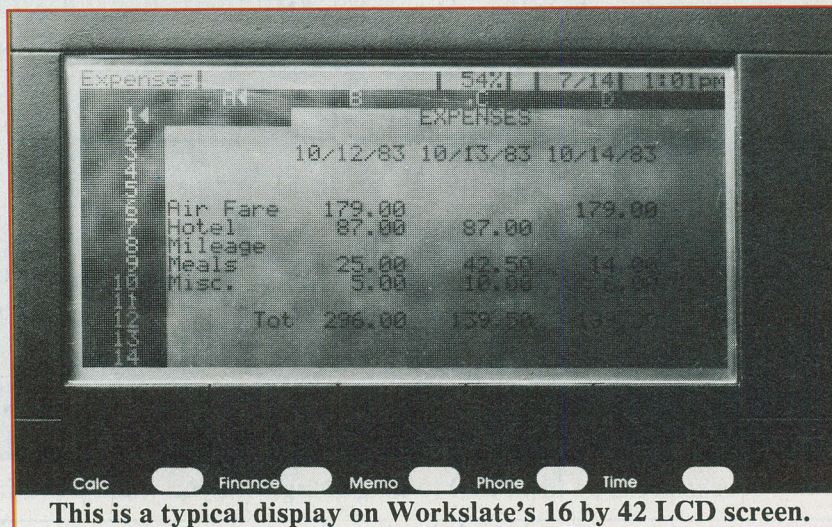
Some common spreadsheet functions of Workslate are copying a cell or cells, totals, average, maximum, minimum, decimals, whole numbers, left or right justify, clearing a cell or cells, inserting rows or columns, and others. Some of the more sophisticated functions are absolute as well as relative cell references, sorting numbers or words (from high to low or low to high, or from A to Z or Z to A), checking for numerical or alphanumeric input, and others.

Three particular functions are assigned green labels on the keyboard (which means they work with the SPECIAL key). FIND is a feature that allows

you to go to any cell on the spreadsheet within the limits of 1 to 128 for rows and A to DX for columns. RECALC permits you to turn off the automatic recalc function (on the menu) and recalculate all values only when desired. SWITCH is used in conjunction with the "Window" feature from the menu. In other words, "Window" shows two different parts of the spreadsheet and SWITCH permits you to move the cursor from one part to the other.

the riddle, "What's a spreadsheet whose 'A' column is 128 characters wide?" can be answered, "Memo Pad."

While we're on the subject, let's discuss "Memo Pad" further. Basically, this worksheet gives you some word processing capability. (I use the term very loosely). You may type up to 128 characters on a line and then press DO IT or the cursor key to begin a new line. If you make any mistakes you must use the change option to edit the line. The



This is a typical display on Workslate's 16 by 42 LCD screen.

I tried some of these functions while developing a spreadsheet and found out the following. To achieve an absolute cell reference, you must precede the cell coordinates with an @ symbol. Another feature concerns entering numbers into a cell. If you begin an entry with a number and then try to input a letter or a space you get beeped. This helps you avoid entering letters in a numeric field. However, if you want to enter a parts number such as 74LS167 into a column, you'll have to begin with a space.

At the top of the display there is a number that tells you the amount of memory left in RAM as a percent (there is 16K total). I was able to reach 0% (memory full) with a 30 x 24 spreadsheet (720 cells). In this state it took over two minutes to perform a simple function such as inserting a blank row into the spreadsheet. And you must remember that five worksheets share the memory. Obviously Workslate isn't meant for heavy-duty spreadsheet work.

Initially, five blank spreadsheets are in memory. Two are classified as "empty," while the others go by the names of "Memo Pad," "Phone List," and "Calendar." The difference between the empty and named worksheets are just some headings, graphics, and modifications of column width. This is really a clever use of the spreadsheet format. So

only way you can make corrections while still on the line is by using the destructive backspace. If you accidentally hit DO IT, CANCEL, or the cursor key instead of pressing SHIFT, you're out of luck. Now you're forced to hit "Change" to continue the line. These factors plus a keyboard that is awkward for word processing make the whole task very tedious.

Other built-in software can be found by pressing the SPECIAL key along with one of the top-row keys. CALC puts you into the calculator mode with basic features such as: M+ -M- -ClrEntry-Recall-StoreM. A calculator display is shown on the lower half of the screen for a realistic effect.

FINANCE allows you to make automatic calculations for depreciation, loans, and net preset value. Fig. 3 shows the menu tree for this key.

TIME allows you to set the date and time upon initial power up (or at any other time). These appear adjacent to each other in the upper right corner of the display. Once they are set, you may subsequently set an alarm for any date and time. Suppose you wanted to remind yourself of Mom's birthday, which is two months from now. Just set the alarm for the correct date and time and you can be sure you'll be reminded about it (if Mom doesn't get to you first). A timer is also included (for min-



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## THE WORKSLATE

utes and hours) so that you can keep track of those long-distance calls. A reset-timer option sets the timer back to zero.

The two other keys, MEMO and PHONE were discussed earlier. Note that any menus related to these keys can be saved with appropriate worksheets. For example, when you save "Calendar," the TIME menu can be saved with it. Remaining built-in software that can be accessed by the user includes the system

per, and can print across the width of the paper or sideways along its length. Normal characters are 1/8" high, but in condensed mode, characters can be printed at half that size. In condensed mode you can get 80 characters along the width of the paper. A sample of the two print modes is shown in Fig. 4. The printer plugs into the back of the unit.

If you would rather use a dot-matrix or letter-quality printer, you can purchase an expander for \$199 that will

be used in conjunction with four AA-size nicad batteries. Alternately, four AA alkaline batteries can be used. To prevent against memory loss, however, you must insert two Eveready 186 (or similar) button-type batteries at the back of the computer.

Thus, once you begin to use Workslate, it will store all inputted data—even when turned off. To delete data, you choose the appropriate menu item.

If nothing has been input to the machine for five minutes or so, it will beep. Unless a key is pressed, it automatically shuts down a minute later to conserve power, but still retains the contents of memory. If desired, the machine can be reset to its initial state by inserting a pen or other pointed object into a small hole on the bottom of the machine.

**How Do I Rate Thee?** Workslate is without question a most interesting and easy-to-use computer. The menu system is impressively good, although at times you may find yourself pushing a lot of buttons to perform a seemingly simple operation. However, because the Workslate holds all the information you put in it, even when turned off, you rarely have to reset parameters after it is done once. I thought the spreadsheet functions were advanced, yet easy to use.

However, as a professional tool, the Workslate's present 16K RAM memory (which is basically used to hold data input) must be questioned. It doesn't take too many cell entries to fill up the memory to capacity. Once that occurs (or almost occurs) the machine becomes unbearably slow. This has to be taken into consideration for those who work with large spreadsheets.

I do not recommend Workslate for any but the most simple word processing needs. The keyboard is awkward for straight typing. But as a spokesperson for Workslate said, "This machine is not meant for people who type their own work." She's right.

Some minor annoyances were the reflections from the display and the unit beeping after five minutes of inactivity, even when using the ac adaptor.

The communications package is excellent and the addition of a telephone amplifier is an indication that Convergent Technologies has thought of just about every convenience.

Workslate's features are geared to the business person who wants spreadsheet capabilities in a portable package without all the fuss of learning about computers. For these people and for others who want a portable business tool, I feel that Workslate has hit its design mark. (Note: Workslate will not be available in computer stores until 1984.) ◇

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Meals	25.00	42.50	14.00
Misc.	5.00	10.00	6.00
Tot	296.00	139.50	199.00

### The optional printer has two modes—standard or compressed.

of menus and a unique "spreadsheet" language. The menu system, which has been alluded to in several parts of this article, is entered into by pressing the OPTIONS key. The menu displays five options at a time and consists of several levels depending upon the application. You can retreat from a lower level all at once by pressing CANCEL or in smaller steps by pressing DO IT. However, it's not always possible to backstep exactly one menu at a time.

Although a language such as BASIC is not included with Workslate, certain "words" are available to the user. I refer to these words as the "spreadsheet" language (how about SSL?). Some of the commands are COUNT, DELAY, INDEX, etc.; other words refer to logical operations such as IF ... THEN ... ELSE, AND, OR, etc.; and some words are mathematical operations such as ABS (absolute value), INT (integer), etc. All of the words that appear in the menus can be typed in, too. An example of the use of this language is shown in Fig. 2.

**Peripherally Speaking.** For those who would like a printer that attaches to Workslate in an aesthetically pleasing way, there is one available for about \$250 (suggested retail price). It's not really a printer though, it's a four-color printer/plotter. It uses 4 1/2" rolled pa-

per give you both an RS-232 and Centronics interface. Parameters for the printer can be set under the menu items "Set Up" and "Printer."

A mass storage device such as a disk drive is not under consideration for Workslate at present.

**Final Considerations.** A few items haven't been addressed yet. First, how does a computer-illiterate person who may also have a touch of compuphobia learn to use Workslate? Included with the package are two instruction tapes called "Teach Me Now" and "Teach Me Later." The tapes weren't available to me for review, but they were described as a way to quickly get your feet wet (Teach Me Now) and a way to learn the machine in depth (Teach Me Later).

The second item is, will any more software be available? The answer to this is yes and no. If by software, you mean something such as a real word processing package—I don't think so. However, there will be tapes available in the future that contain templates similar to those used for "Memo Pad," "Phone List," and "Calendar." These "Taskware" tapes will be for applications such as Real Estate, Taxes, etc.

The last item, which we've already touched on briefly, has to do with power considerations. The basic unit comes with an ac adapter/recharger. This may



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## H-100 SERIES COMPUTER SPECIFICATIONS:

**USER MEMORY:**  
192K-768K bytes\*

**MICROPROCESSORS:**  
16-bit: 8088  
8-bit: 8085

**DISK STORAGE:**  
5.25" disk drive,  
8" disk drive  
Winchester drive

**KEYBOARD:**  
Typewriter style, 95 keys,  
13 function keys,  
18-key numeric pad

**GRAPHICS:**  
Always in graphics mode.  
640h/225v resolution; up to  
eight colors are available\*\*

**COMMUNICATIONS:**  
Two RS-232C Serial  
Interface Ports and  
one parallel port

**DIAGNOSTICS:**  
Memory self-test  
on power-up

**AVAILABLE SOFTWARE:**  
Z-DOS (MS-DOS)  
CP/M®  
Z-BASIC Language  
Microsoft BASIC  
Multiplan  
SuperCalc  
WordStar

MailMerge  
Data Base Manager  
File Manager  
General Ledger  
Accounts Receivable  
Accounts Payable  
Inventory Control  
Sales Invoicing  
Lotus 1,2,3  
PeachText 5000  
Fortran-86  
Cobol-86  
Pascal  
Basic Compiler  
Most standard  
8-bit CP/M  
Software

The H-100 is easy to build – the step-by-step Heathkit manual shows you how. And every step of the way, you have our pledge – "We won't let you fail." Help is as close as your phone, or the nearest Heathkit Electronic Center.† And what better way to learn state-of-the-art computing techniques than to build the world's only 16-bit/8-bit computer kit? To run today's higher-speed, higher-performance 16-bit software, you need an H-100. It makes a big difference by processing more data faster.

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For more information, circle the reader service number below. Better yet, visit your Heathkit Electronic Center for a demonstration!

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\*192K bytes standard.

\*\*Optional.  
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Circle No. 28 on Free Information Card



# Customize Your Apple with an EPROM Plug

*Here's a simple way to change the standard ROMs in your Apple II*

*By S. F. Mitchell, Jr.*

**H**ow would you like to customize your Apple II without making hardware modifications and be able to change back to the original condition in about 30 seconds? The EPROM plug discussed here allows you to replace the Apple Autostart ROM (F8) with a specially programmed EPROM. This means you can make firmware changes without making hardware or software modifications.

The EPROM plug accepts the Texas Instruments TMS2516 EPROMs (or Intel's 2716, or similar) in place of any of the original Apple ROMs (or all if you wish to make more extensive firmware changes). By substituting EPROMs in place of the Apple ROMs, you can customize an Apple II to the limit of your programming ability. Detailed instructions follow for changing the "Apple II" title display, eliminating the lower-case sieve routine, permitting a title of up to 14 characters, adding a security code to uniquely identify your Apple, changing the system monitor routine prompt character, and modifying the NMI vector to allow regaining control of the computer from any program.

Since the EPROM plug accepts the TMS2516 EPROM, you must have a way of programming this chip. Alternately, you can use a professional EPROM programming service (such as the one given in the Parts List on the opposite page) to create a custom EPROM for your Apple.

**The EPROM Plug.** The EPROM plug is easily constructed with the proper kind of machined-pin sockets (Augat 524-AG10D, or similar). Using these special sockets, with the diagram at right as a

guide, carefully clip the narrow ends of pins 18 and 21 from the socket that will be used on top (SO1). As shown, the pins are clipped at the point where they narrow. Dress the clipped pins with a small file so that when SO1 is plugged into the bottom socket (SO2), these pins *do not* make electrical contact with SO2. Eventually, SO2 will plug into the Apple motherboard.

Prepare two 1½" lengths of wire-wrap wire by stripping ¼" of insulation from each end. One end of a wire is soldered to pin 18 on SO1, with the other end inserted in, and soldered to, pin 21 on SO2. Use a small-tip, low-wattage soldering pen and narrow diameter solder. Trim any excess bare wire after soldering, and be careful that no bare wire is left exposed that could short circuit to an adjacent pin.

Using the same technique, solder the other wire from pin 21 on SO1 to pin 18 on SO2. Plug SO1 into SO2 and check to make sure that pins 18 and 21 on SO1 *do not* make contact with the correspond-

ing pins on SO2. Fold the excess wire so that it lays flat and is sandwiched between the two sockets, which should seat together firmly.

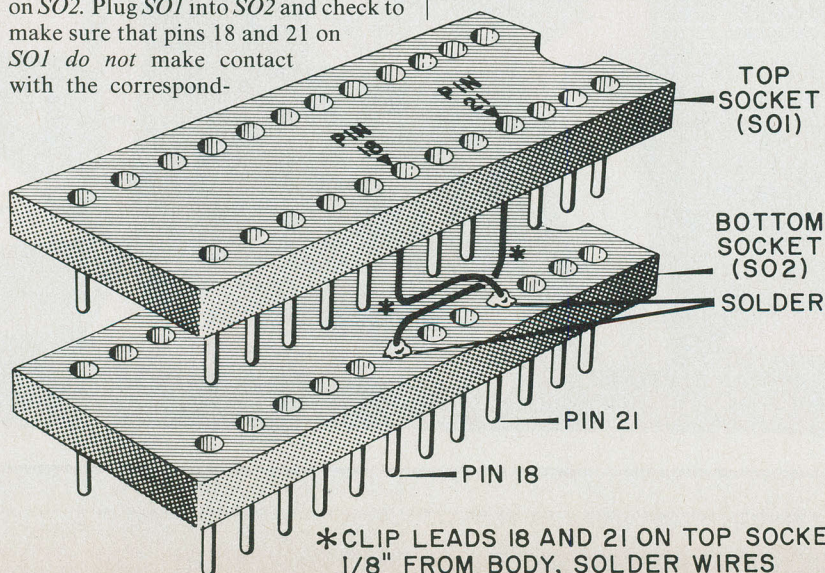
Use a continuity tester to determine if the clipped pins are touching the mating holes on SO2. If so, pry the sockets apart and dress the clipped pins again so they don't touch the holes. Resolder the leads if required. With the continuity checker, assure that there is continuity between pin 18 of SO1 and pin 21 of SO2, and between pin 21 of SO1 and pin 18 of SO2. If everything checks out, a permanent bond should be made between SO1 and SO2.

Employing a fine-tipped soldering iron and fine solder, carefully solder together the four corner pins of the two sockets (pins 1, 12, 13, and 24). However, this soldering is difficult, and you may scar the plastic of the sockets slightly with heat from the soldering pen. The scarring will not hurt the sockets, though. At this point, check for continuity between similar pins on both sockets (except for pins 18 and 21). It may be necessary to solder some pins.

As an option, fill the gap between the two sockets with some type of filler, such as epoxy. The filler is not necessary for using the EPROM plug, but it makes it look neat. If you do use filler, however, make sure that it is electrically nonconductive!

**Customizing the Apple.** The Apple Autostart ROM (F8) contains many of the machine-language subroutines that make the Apple powerful. Here are a few customizing ideas that you might want to try.

**Title.** When an Apple with an Autostart ROM is powered up, the screen is cleared and "APPLE II" appears centered at the top of the screen. This first example involves changing "APPLE II" to another title—your





name or, for the sake of this demonstration, "ORANGE 2." The letters for "APPLE ][]" are stored in locations \$FB09 to \$FB10 (Note: a \$ precedes hexadecimal numbers). The present contents of these locations are:

```
$FB09 = C1 (A)
$FB0A = D0 (P)
$FB0B = D0 (P)
$FB0C = CC (L)
$FB0D = C5 (E)
$FB0E = A0 (Space)
$FB0F = DD (J)
$FB10 = DB (I)
```

Since we know where the locations are in the F8 ROM, it is easy to change them. If you are not familiar with programming EPROMs, the following is a brief summary of how to do it.

For Apple disk systems, boot DOS; for cassette systems, simply power the Apple up. From this point to saving the code on disk or cassette, the procedure is the same. Type CALL -151 (RETURN). You should now be in the system monitor. An asterisk (\*) appears for a prompt. Type FB09.FB10 (RETURN). You should see C1 D0 D0 CC C5 A0 DD DB. These are the contents of the locations that we will ultimately change, but first we have to move the *entire* F8 ROM into RAM. To make the move, type 2000<F800.FFFFFM (RETURN). This moves the F8 ROM contents down to RAM locations \$2000 to \$27FF. (Keep in mind that \$ equals hex.) The F8 ROM memory page boundaries are now in the following locations in RAM:

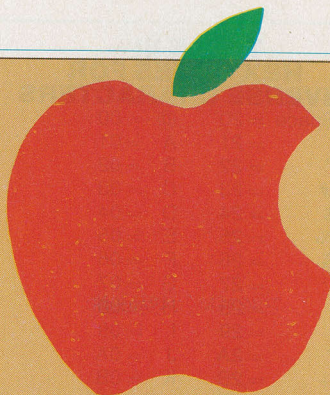
```
$F800 = $2000
$F900 = $2100
$FA00 = $2200
$FB00 = $2300
$FC00 = $2400
$FD00 = $2500
$FE00 = $2600
$FF00 = $2700
```

#### PARTS LIST

IC1—Texas Instruments TMS2516JSP-45 EPROM or exact electrical equivalent  
SO1,SO2—24-pin IC socket with gold-plated, screw-machined pins (Augat 524-AG10D or equivalent)

Misc.—Wire-wrap wire

**Note: The following are available from Martcomm, Inc., PO Box 74, Mobile, AL 36601: Two 24-pin, gold-plated, screw-machined pin sockets for \$8.25 plus \$1.75 for postage; two sockets assembled as described in text for \$14.95 plus \$1.75 postage; TMS2516 EPROMs for \$6.50 each, plus \$1.75 postage. For programming, send \$10.00 plus a tape or disk prepared as described in the text. Alabama residents add sales tax.**



#### APPLE II KEYBOARD MODIFICATION

LIFT off the top of the Apple and locate the pc board under the keyboard. There is a row of 25 wire pins that connect the pc board to the keyboard. Attach a wire to the second pin from the right (as you face the Apple). Attach the other end of the wire to pin 4 of the game port socket. Alternately, you can connect the wire to pin 1 of the IC just in front of the game port socket (74LS251).

From the above memory page offset table, we see that the locations we want to change, \$FB09 to \$FB10, are now located at \$2309 to \$2310. Confirm this by entering 2309.2310 (RETURN). Again we should see C1 D0 D0 CC C5 A0 DD DB. We must now decide what changes to make to these codes for "ORANGE 2" instead of "APPLE ][."

Table I shows normal ASCII screen characters, which we want for this example, but you can use any combination of normal, flashing (Table II), or inverse (Table III) characters. If you have a lower-case character generator, you could even use lower-case characters. Refer to your lower-case character generator manual for the appropriate codes.

The following codes are from Table I:

```
0 = CF
R = D2
A = C1
N = CE
G = C7
E = C5
(space) = A0
2 = B2
```

Keep in mind that there are only eight locations available for the title and that spaces count.

To replace the original "APPLE ][]" with "ORANGE 2," type 2309: CF D2 C1 CE C7 C5 A0 B2 (RETURN). This procedure changes RAM locations \$2309 to \$2310 to the desired codes for the new message. The changes can be checked by typing 2309.2310 (RETURN). The only thing left is to save the changes to disk or cassette. If you

**TABLE I—  
HEX CODES FOR  
NORMAL CHARACTERS**

Space	= A0	@	= C0
!	= A1	A	= C1
"	= A2	B	= C2
#	= A3	C	= C3
\$	= A4	D	= C4
%	= A5	E	= C5
&	= A6	F	= C6
'	= A7	G	= C7
(	= A8	H	= C8
)	= A9	I	= C9
*	= AA	J	= CA
+	= AB	K	= CB
,	= AC	L	= CC
-	= AD	M	= CD
.	= AE	N	= CE
/	= AF	O	= CF
0	= B0	P	= D0
1	= B1	Q	= D1
2	= B2	R	= D2
3	= B3	S	= D3
4	= B4	T	= D4
5	= B5	U	= D5
6	= B6	V	= D6
7	= B7	W	= D7
8	= B8	X	= D8
9	= B9	Y	= D9
:	= BA	Z	= DA
;	= BB	[	= DB
<	= BC	\	= DC
=	= BD	]	= DD
>	= BE	^	= DE
?	= BF	_	= DF

**TABLE II—  
HEX CODES FOR  
FLASHING CHARACTERS**

Space	= 60	@	= 40
!	= 61	A	= 41
"	= 62	B	= 42
#	= 63	C	= 43
\$	= 64	D	= 44
%	= 65	E	= 45
&	= 66	F	= 46
'	= 67	G	= 47
(	= 68	H	= 48
)	= 69	I	= 49
*	= 6A	J	= 4A
+	= 6B	K	= 4B
,	= 6C	L	= 4C
-	= 6D	M	= 4D
.	= 6E	N	= 4E
/	= 6F	O	= 4F
0	= 70	P	= 50
1	= 71	Q	= 51
2	= 72	R	= 52
3	= 73	S	= 53
4	= 74	T	= 54
5	= 75	U	= 55
6	= 76	V	= 56
7	= 77	W	= 57
8	= 78	X	= 58
9	= 79	Y	= 59
:	= 7A	Z	= 5A
;	= 7B	[	= 5B
<	= 7C	\	= 5C
=	= 7D	]	= 5D
>	= 7E	^	= 5E
?	= 7F	_	= 5F



are using a disk, type BSAVE ROMF8,A\$2000,L2050 (RETURN). The program should now be saved on disk.

If you are using a cassette recorder, type 2000.2800W, place the recorder in record, wait about five seconds, and hit RETURN. The saved code can be used with an EPROM programmer to program your EPROM. If you don't have an EPROM programmer, you can use a professional programming service.

**Lower Case.** If you have modified your Apple keyboard to generate lower-case characters, you might want to eliminate the lower-case sieve that is in the F8 ROM keyboard-input routine. This is easily accomplished by changing ROM locations \$FD82 and \$FD83 from \$29 \$DF to \$EA \$EA. After the change, typing a lower-case character on the keyboard actually gets the character into the Apple (past the keyboard-input routine) as a lower-case character. Again, the actual changes are made in RAM after you have moved the ROM contents down to RAM, as previously described. Therefore, the actual locations that you will change are \$2582 and \$2583 in RAM. Type 2582:EA EA (RETURN) to make the change. Verify that the change was properly made by typing 2582.2583 (RETURN). If the change was properly made, you will get EA EA. After the change, you must save the code on tape or disk to program your EPROM. (See box.)

**Longer Title.** There are 14 "free" locations in the F8 Autostart ROM that can be used for a short machine-language subroutine or, if you like, a 14-character title. These "free" locations are \$FBB3 to \$FBC0. To create a 14-character title, the F8 ROM "Print the Title" routine at locations \$FB63 to \$FB6A must be changed. The 14 characters that you want for your new title will be placed in locations \$FBB3 to \$FBC0. First, move the F8 ROM down to RAM locations \$2000 to \$27FF, then make the following changes in RAM by typing:

2363: A0 0E B9 B2 FB 99 0A 04 (RETURN)

This change allows 14 letters in the title, centered on the screen. The 14-character title must be placed in locations \$FBB3 to \$FBC0, with the characters selected from the normal, inverted, or flashing character tables. If you use less than 14 characters, you must "center" the characters in the 14 locations by using leading and trailing space characters (\$A0). Assuming that you have already moved the F8 ROM down to RAM, the 14 locations for your new title are now at locations \$23B3 to \$23C0. The usual

**TABLE III—  
HEX CODES FOR  
INVERSE CHARACTERS**

Space	= 20	@	= 00
!	= 21	A	= 01
"	= 22	B	= 02
#	= 23	C	= 03
\$	= 24	D	= 04
%	= 25	E	= 05
&	= 26	F	= 06
'	= 27	G	= 07
(	= 28	H	= 08
)	= 29	I	= 09
*	= 2A	J	= 0A
+	= 2B	K	= 0B
,	= 2C	L	= 0C
-	= 2D	M	= 0D
.	= 2E	N	= 0E
/	= 2F	O	= 0F
0	= 30	P	= 10
1	= 31	Q	= 11
2	= 32	R	= 12
3	= 33	S	= 13
4	= 34	T	= 14
5	= 35	U	= 15
6	= 36	V	= 16
7	= 37	W	= 17
8	= 38	X	= 18
9	= 39	Y	= 19
:	= 3A	Z	= 1A
;	= 3B	[	= 1B
<	= 3C	\	= 1C
=	= 3D	]	= 1D
>	= 3E	^	= 1E
?	= 3F	_	= 1F

contents of locations \$23B3 to \$23C0 are 14 \$EA characters, the 6502 microprocessor NOP code (No Operation, or "do nothing" code). Change the 14 locations as follows (where the XX represents the codes you have selected from Tables I, II, or III):

23B3: XX XX XX XX XX XX XX XX  
XX XX XX XX XX XX (RETURN)

After the changes, save the code from \$2000 to \$2800. The saved code is used to program your EPROM.

**Title Call.** After you have your personalized title working and want to use it in a program, CALL — 1184 will clear the display and put your title on the screen. If you are in the system monitor, typing FB60G (RETURN) will do the same.

**Security Code.** The 14 locations from \$FB63 to \$FBC0 can also be used to uniquely identify your Apple. Simply place your own security code (social security number, serial number, etc.) in these "free" locations. If you make this change, your Apple will be unique since it will be the only one existing with your identification in EPROM. The characters that you want for identification should be selected from Table I since you will not be printing the security code on the screen. As usual, first move the F8 ROM contents down to RAM. Then enter the "security" code by making changes starting at location \$23B3.

The changed code should be saved on tape or disk for programming your EPROM.

**Monitor Prompt.** It is a good idea to change the system monitor prompt if you substitute an EPROM for the F8 System ROM. The nonstandard prompt character will remind you that the original ROM is not installed in the Apple. The code for the system monitor asterisk prompt (\$AA) is located at \$FF6A. To change the prompt character to a flashing asterisk, for example, consult Table III, which indicates that the proper code is \$2A. Therefore, the code at \$FF6A must be changed to \$2A. Assuming that you have moved the ROM contents down to RAM, the location to change will be \$276A. Make the change in RAM with the system monitor by typing 276A: 2A (RETURN). Verify that the change was made, and save the changed code on cassette or disk for programming your EPROM.

**NMI Vector.** Most protected programs prevent the user from going into the system monitor where the program can be examined. By changing the NMI (non-maskable interrupt) vector to return to the system monitor, control can be regained from any program. This is accomplished by changing F8 ROM locations \$FFFA and \$FFFB from \$FB \$03 to \$69 \$FF. Remember, \$FFFA and \$FFFB will be locations \$27FA and \$27FB in RAM, where the changes are actually made. Type 27FA: 69 FF (RETURN) to make the change. Verify that the change was made by typing 27FA.27FB (RETURN), which should give you 69 FF. Save the changed code on disk or tape for use in programming your EPROM.

After this change, you can return to the system monitor from any program simply by grounding the NMI line on the system bus. A single-pole, single-throw, momentary pushbutton switch will suffice. The switch should be connected so that closure grounds pin 29 of one of the peripheral connectors (which connects to the NMI pin on the 6502 microprocessor).

Some "protected" programs do a checksum test on the F8. If there have been any changes to the ROM, the protected program aborts or hangs up.

**Using the EPROM Plug.** After burning your custom program into an EPROM, insert it into the EPROM plug with pin 1 of the EPROM toward the notch in the top socket (pin 1 is usually identified by a dot or notch). Make sure the Apple is turned off and unplugged from the ac power line, then replace the desired Apple ROM with the EPROM plug, keeping the notch toward the keyboard end of the motherboard. ◇



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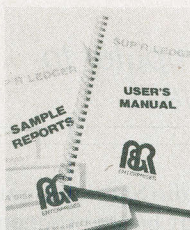
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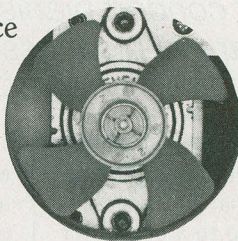
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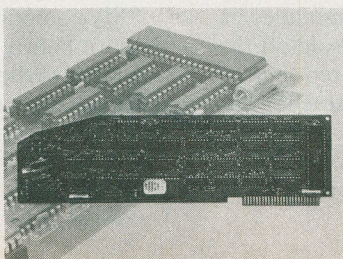
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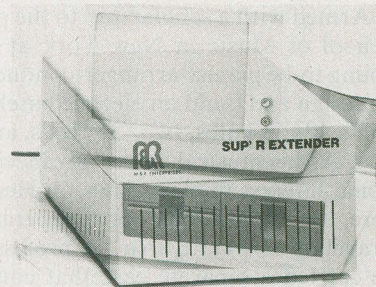
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# PETER NERO

## *at the Computer Keyboard*

*How a busy concert pianist uses his computer to  
take care of business and travel affairs*

**N**O tumultuous applause greets celebrated pianist Peter Nero when he finishes at the keyboard. Not when it's a computer keyboard rather than a Steinway. But switching from a piano to a computer has become a vital part of Nero's business life as well as satisfying his lifelong technical curiosity.

Armed with a scholarship to the prestigious Juilliard School of Music in New York at the age of 14, the young to-be pianist-arranger-conductor still found time to design and build an electric baseball game that used 35 flashlight bulbs, two "D" cells, and multicolor overlays. As his musical career advanced, so did his avocational interest in electronics. A Heathkit digital clock here, an indoor/outdoor temperature device there. Traveling constantly to make professional appearances, he carried a separate case that contained a soldering iron, hand tools, and an electronics kit he was working on while in one city or another.

As career success usurped more and more of his spare time, he gave up the joy of building electronic projects. He still kept an eye peeled for unique kits, though, hiring surrogates to build them. At this juncture, he began an affiliation with Radio Shack, specifically concerning its line of stereo equipment. During his Audio Period, he gained an interest in synthesizers too, from Bob Moog's patch-cord machine to polyphonic modules on plywood. After about six or seven years, he sold off the synthesizers. He ran the gamut on stereo equipment—parametric graphic equalizers, four-track open-reel tape recorders, AKG mikes for piano recording, and so on—but does little recording at home. "You can't beat a professional recording studio," he concluded.

His work with Radio Shack led naturally to computers when the company began producing them. "I've got a Model I with a 00026 serial number!" Nero exclaimed. He also has a Model III desktopper with two built-in disk drives, two line printers, a daisy-wheel printer, color computer (COCO), four separate disk drives, a modem, two portable data terminals, a voice synthesizer, a printer interface selector, a "Plug 'N Power" controller with receiver modules, and surge/filter power supplies, along with all the other accoutrements that computerists gather unto themselves.

Yes, Peter Nero has added computing to his other technically oriented activities. Interestingly, a private tutor gave him lessons at his West Coast home on how to write programs in BASIC.

Computers quickly became a valuable tool for Nero. "This is an industry, not a career," he jocularly said. "I have about 100 different engagements every year, some one-nighters, others longer," he explained. "So there are plans to be made such as scheduling flights, making hotel reservations, information for my manager, a couple of agents, public relations people, an accountant, a lawyer." Expounding further, he observed that "there is payroll information, rehearsal data, contract terms for each engagement, etc."

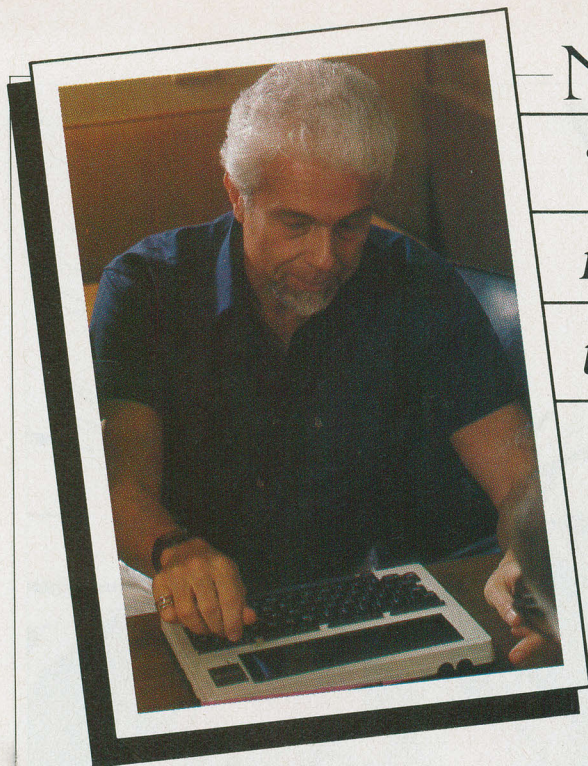
"My computers relieve me of a lot of paperwork," he noted. "Before I used them, I carried around an enormous leatherbound notebook wherever I went, continually entering all this information. Now I use my TRS-80 Model 100 portable when I'm on the road."

Precisely what does he do with a battery-powered portable computer? He maintains an address-phone book listing for fingertip information retrieval, his itin-









**He uses a TRS-80 Model 100 to store information while on the road.**

enary with dates and terms or contracts, payroll data, tracking of airline mileage, a spreadsheet he wrote for his personal financial forecasts, music program listings he's played and where and when performed, personnel used on different engagements, rehearsal information, days-off plans, and word processing, to name a few applications. Nero can retrieve information he needs virtually instantly now, overcoming the problems he had in pre-computer days that forced him to scan many pages of notes to find out, say, how well an oboe player performed at a certain concert.

He can also upload information to his office computers, use a computer network to get the latest airline schedules, etc. He taught his secretary how to use the computer system back at the office. However, he still has some lessons to teach in order to pass data back and forth by telephone.

He subscribes to The Source network and also plans to join CompuServe soon. In addition, he uses the Official Airline Guide extensively to check out flight plans. For this service there's a one-time charge of \$50 plus time. His first month's bill was about \$40.

Asked why he bothers to keep records of airplane mileage, he replied: "Airlines generally have a bonus program for miles travelled. There are a variety of bonuses offered. Since I travel constantly—I put 250,000 miles on United Airlines flights alone the past two years—this allows me to catch discrepancies that the carriers make in their records. It only takes 10,000 miles to get a bonus upgrade," Nero explained, "which means an awful lot of upgrade points for someone who travels as much as I do."

Peter Nero expressed little interest in computer games or graphics, sticking strictly to alphanumerics. He has a "Read Program" written for the TRS-80 Model 100 that reformats all ".DO" files so that each one is

## NERO

*"My future is in  
my computers, especially  
the portable."*

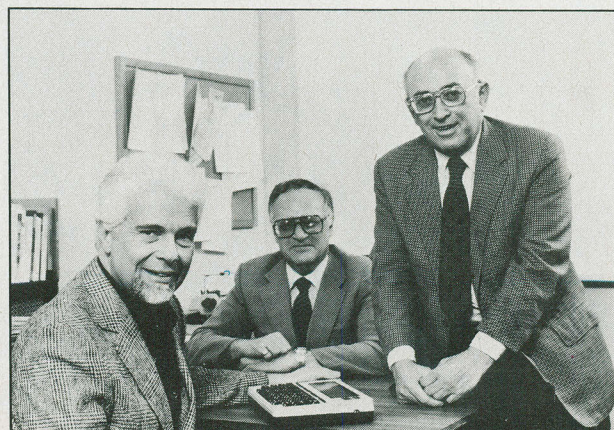
callable, paginated and numbered, as shown in an accompanying listing (Example 1). Each page can be read by pressing ENTER rather than by using the SHIFT or CONTROL keys and Up and Down arrows. (Nero has since modified this program to make it more sophisticated.)

"I discovered that the number of title files on the 100 is limited to 20," he said. "Since many of my files are short, taking very little space, I devised a section in the 'Read Program,' starting at line 6000, that I call 'Sub-files' (Example 2). This stacks all smaller files and come up on the 100's screen as 'SF.DO'" (Example 3).

"I still enter data in the usual TEXT format," Nero continued. "No INPUT section is needed. In fact, I found that I don't need an INPUT section for any BASIC program with the Model 100. Data can be stored using the TEXT File mode, packing them very tightly on one line through use of codes and abbreviations. Then a BASIC program can be written to pull out this information from RAM, employing PRINT USING statements to format for screen or LPRINT USING for printer. Also, data or conditional statements can be used to define codes and abbreviations." [The TEXT program is actually a reasonably effective word-processing program in ROM that uses ASCII files.]

Nero apologized for the odd numbering of his program lines. "I haven't added a Renum Program, which the 100 doesn't incorporate. Also, some lines run off the paper because "PRINT A\$(2) is missing."

"I wrote a program called Payroll for a Model I. Since my DOS has a screen printout feature, I was able to eliminate separate LPRINTS." Printouts, using fictitious names and numbers, are illustrated here. Example



**Nero discusses his computer programs with two C&E editors.**



# NERO

```

20 '**** READ PROGRAM ****
30 '** COPYRIGHT 1983 PETER NERO **
40 CLEAR2000
50 DIMA$(100)
52 CLS
55 PRINT@10,DATE$+" "+TIME$
57 PRINT@46," READ FILE PROGRAM ":PRINT
58 PRINT" (Note:Enter E to exit at anytime)":PRINT
60 LINEINPUT" NAME OF FILE(HIT ENTER TO END)":G$
65 IFG$=" "THENCLS:PRINT@176,"END":FORY=1TO150:MEN
70 G$=G$+".DO"
90 IFG$="SF.DO"THEN6000
100 CLS
180 ONERRORGOTO1000
200 OPEN G$ FORINPUTAS1
210 LC=0:Z=1:Y=0
240 FORX=YT0100
260 LC=LC+1
300 IFEOF(1)THEN5100
350 QQ$="↓↓Page## ↓"
400 INPUT#1,A$(X)
420 QZ$=LEFT$(A$(0),1)
460 IFLEFT$(A$(X),1)="-"THEN5100
500 AA$=MID$(A$(0),9,27)
610 IFX=0THENGOSUB7000:ELSEPRINTA$(X)
662 IFLC=7THENGOSUB4000:CLS:IFG$="BETTY.DO"ANDLC=7THENZ
=Z+1:LC=3:GOSUB7
669 IFLC=7ANDG$<<"BETTY.DO"THENLC=1:Z=Z+1:GOSUB7000
800 NEXT
900 CLOSE
1000 IFERR=52THEN1020
1020 LL=0
1030 PRINT@171," No such file!"
1040 FORW=1TO75:NEXT
1060 LL=LL+1
1062 CLS
1070 IFLL=3THENRUN
1080 GOTO1030
4000 E$=INKEY$
4020 LINEINPUT$
4040 IFE$="E"OR E$="e"THENCLS:PRINT@174,"NEXT FILE":
FORY=1TO150:NEXT:GO
5000 '
5020 INPUT" End of File. More Sub-Files(Y/N)":R$
5040 IFR$="Y"THENCLOSE:GOTO6000:ELSERUN
5100 PRINT" End of File "
5120 LINEINPUTW$
5140 IFW$<<" "THEN5140:ELSERUN
6000 '
6010 CLS
6014 PRINT@10," Sub-Files "
6020 PRINT" (1)KK (7)R/S"
6022 PRINT" (2)ROY (8)PP"
6024 PRINT" (3)BD (9)CPB"
6026 PRINT" (4)EDDIE (10)REP"
6028 PRINT" (5)LEN"
6030 PRINT" (6)HOUSE"
6040 INPUTSF$
6050 IFSF$=" "THENRUN
6060 CLS
6080 OPENG$FORINPUTAS1
6100 LC=0:Z=1:Y=0
6120 FORX=YT0100
6140 INPUT#1,A$(X)
6150 ONERRORGOTO1000
6170 IFVAL(SF$)>9THENQZ$=MID$(A$(X),2,2):ELSEQZ$=MID$
(A$(X),2,1)
6180 IFSF$<<QZ$THENNEXT
6200 QQ$="↓↓Page## ↓"
6210 AA$=MID$(A$(X),9,27)
6220 GOSUB7000
6240 A$(0)=A$(X)
6250 Y=1:LC=1:Z=1
6260 FORX=YT0100
6270 LC=LC+1
6280 INPUT#1,A$(X)
6300 IFLEFT$(A$(X),1)="-"THEN5000
6310 PRINTA$(X)
6320 IFLC=7THENGOSUB4000:CLS:Z=Z+1:LC=1:GOSUB7000
6400 NEXT
6500 CLOSE
6520 GOSUB4000
6540 RUN
7000 PRINTUSINGQQ$:QZ$:Z:AA$:RETURN
20000 SAVE"TEST"

```

Peter Nero's Read Program

```

4 Page 1 ***** EDDIE GROSSI ****
PATIO HARDWARE
PN/OFFICE LIGHT KNOB
SASH
OUTSIDE SHELF
SCREEN DOOR
End of File. More Sub-Files(Y/N)?

```

## Example 1

```

Sub-Files
(1)KK (7)R/S
(2)ROY (8)PP
(3)BD (9)CPB
(4)EDDIE (10)REP
(5)LEN
(6)HOUSE
?

```

## Example 2

```

Jly 19,1983 Tue 10:28:06 (C)Microsoft
BASIC TEXT TELCOM ADDR$
SCHEDL ITIN84.DO ADRS.DO NOTE.DO
JOAN.DO PN.DO PEND.DO PLN.DO
LAURA.DO ITIN83.DO REP.DO SF.DO
PAY83.DO BETTY.DO CALC.BA PAY.BA
ITIN.BA READ.BA -.- -.-
Select: _ 10519 Bytes free

```

## Example 3

```

< 1 > INPUT OR UPDATE DATA
< 2 > PRINT DATA FOR ACCT.
< 3 > PRINT RECAP FOR ACCT.
< 4 > PRINT RECAP FOR EMPLOYEE
< 5 > INITIALIZE EMPLOYEES
PICK A NUMBER _

```

## Example 4

\*\*\* INPUT SECTION \*\*\*

```

ENTER DATE(MMDYY).....071983
ENTER CITY( 9 LETTERS MAX.).....DAYTON OH
**** CORRECTIONS (Y/N).....? _

```

## Example 5

```

JULY 19, 1983, DAYTON OH
FEE.....? 00000
FARE REIMBURSEMENT (Y/N).....? Y
(SMITH/JONES)
SALARY(---/---).....? 500/500
NUMBER OF EXTRA REHEARSALS(-/-).....? 1/1
NUMBER OF DAYS OFF REIMBURSEMENT(-/-).....? 1/1
NUMBER OF SETUPS (RN ONLY).....? 2
MISC. EXPENSE REIMBURSEMENT(---/-/---).....? 142.30/1
33.26
PHILLY POPS REIMBURSEMENT(---/-/---).....?
**** CORRECTIONS (Y/N).....? _

```

## Example 6





*“He’s also interested  
in utilizing his  
computers as controllers.”*

FINGER PRINCE, INC.: PAYROLL  
PAYROLL INFO FOR JULY 19, 1983; DAYTON OH  
FEE= \$0 : TRANSPORTATION INCLUDED: YES. AMOUNT>>

	* SMITH		* JONES	
	TAXABLE	NON-TAXABLE	TAXABLE	NON-TAXABLE
SALARY	\$500		\$500	
REHEARSAL	\$75		\$75	
SETUP(S)		\$40		
DAY(S) OFF		\$20.00		\$20.00
MISC. EXP.		\$142.30		\$133.26
PHL REIMB.	\$0		\$0	
TOTALS	\$575	\$202.30	\$575	\$153.26

### Example 7

		SUMMARY FOR SMITH					AND JONES					
		* SMITH					* JONES					
DATE	CITY	SAL	REH	SU	MISC	PHLP	OP	SAL	REH	MISC	PHLP	OP
JUL 19	DAYTON OH	500	75	40	162	0	0	500	75	154	0	0
JUL 20	CLEVELAND	500	150	60	33	0	0	500	150	104	0	0
JUL 1	ERIE PA	250	0	0	100	-13	0	450	0	90	-137	0
TOTAL		1450	225	120	315	-137	0	1450	225	357	-137	0

[illegible]

### Example 8

***** PAYROLL INFO FOR SMITH *****									
TOTALS									
DATE	CITY	SAL	REH	SU	MISC	PHLP	OP	TAXABLE	REIMB.
JUL19	DAYTON OH	500	75	40	162.30	0.00		575.00	202.30
JUL20	CLEVELAND	500	150	60	52.50	0.00		650.00	112.50
JUL21	ERIE PA:	450	0	20	100.00	-137.00		313.00	120.00
=====									
TOTAL		1450	225	120	314.80	-137.00		1538.00	434.80

[illegible]

### Example 9

***** PAYROLL INFO FOR JONES *****									
DATE	CITY	SAL	REH	MISC	PHLP	OP	TAXABLE	REIMB.	
JUL19	DAYTON OH	500	75	0	153.26	0.00	575.00	153.26	
JUL20	CLEVELAND	500	150	0	104.00	0.00	650.00	104.00	
JUL21	ERIE PA:	450	0	0	100.00	-137.00	313.00	100.00	
TOTAL		1450	225	0	357.26	-137.00	1538.00	357.26	

[illegible]

### Example 10

4 shows what the screen looks like on the menu section. Example 5 shows the screen for INPUT, where the program searches the file for duplications that come up on the screen for deleting or editing. Example 6 shows the screen output for this section. Example 7 shows a summation of the INPUT section, while Example 8 is designed to be sent to the bookkeeper who makes appropriate deductions and then processes the check. RECAPS (Example 9 and 10) are then sent to each employee.

"My future is in my computers, especially the portable," Nero says. "It gives me more time to attend to my musical career. I haven't tackled assembly language yet . . . maybe one day. My portable's 32K is very powerful, but sometimes I do run out of memory when I'm on the road for, say, two or three weeks. I store data on tape when that happens."

When Nero programs, he sets a flow chart mentally and then picks lines for categories. He uses subroutines as much as possible, as well as subfiles with markers to denote beginnings and endings. To demonstrate, he punched in some programs on his Model 100. One "bombed." Numerical data came up on a different line of the display. Nero promptly ran several sections on the LIST mode, all the while mumbling to himself. In short order, he verbalized a flowchart, identifying the variables until he came up with the one he wanted. He then made some changes, re-ran the program, mumbled a little again as he concentrated, did another verbal flowchart, found another variable, and, bingo!, solved the problem.

What computer does he want? Being a musician, he'd like a system connected to his computer that will score what he plays on piano and display it on a video screen . . . with printout capabilities, of course. He's intrigued by the possible roles that might be played by microcomputer-controlled robots in the future, expecting them one day to take over a variety of menial tasks. Right now, though, he plans to give some attention to analog-to-digital and digital-to-analog converters with appropriate sensors to, say, sense when his lawn needs sprinkling. He's also interested in utilizing his computers as controllers, and was pressing for more information on using house power lines to carry data to and from his computers. "I saw an ad in a J & S catalog . . ."

In sum, Peter Nero, a leading music personality, can capsule his views about computers and computing by referring to the number he played on an NBC Emmy-Award-Winning tribute to George and Ira Gershwin: “S’Wonderful, S’Marvelous.”  $\diamond$



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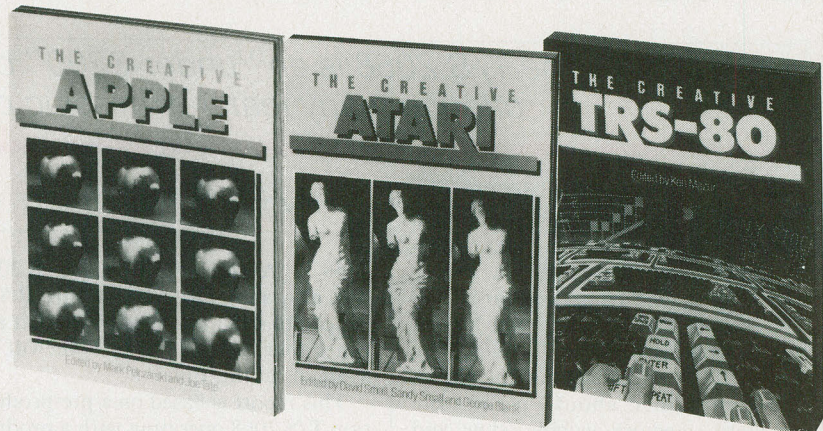
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# First Look at Timex/Sinclair's New Color Computer

*The T/S 2068 is an "under-\$200" basic computer offering many features missing on the 1000*

**T**HE new Timex Sinclair 2068 Personal Color Computer is much different than the computer originally announced at a trade show in January 1983 as the "Timex Sinclair 2000." The computer has gone through a great metamorphosis. Those of you having Timex 1000s will find that the things you complained about—membrane keyboard, memory wobble, slow and unreliable cassette loading, limited BASIC language, no color, no sound, limited graphics, etc.—have been corrected in the T/S 2068. With 48K of on-board RAM, the machine has evolved into a sophisticated "under-\$200" basic computer offering many special features.

**Background.** In April 1982, Timex made an agreement with Sinclair Research Ltd. in England to utilize Sinclair computer technology for computers to be made under the "Timex Sinclair" label and distributed in North America. The Timex 1000 was an almost direct copy of Sinclair's ZX81 and, according to the *Wall Street Journal*, Timex sold 550,000 T/S 1000s in five months!

When Sinclair came out with its low-priced color computer, the Spectrum, in mid-1982, it was assumed Timex would bring it into North America very quickly. Indeed, the original Timex Sinclair 2000 shown to dealers and press in January appeared to be a Spectrum in a slightly restyled case—same size, same keyboard, same specifications.

But the introduction of the T/S 2000 was delayed and rumors abounded. Finally, at a June 1983 industry show, Timex unveiled the Timex Sinclair 2068, which bore no physical resemblance to the Spectrum at all! By the time you read this, the T/S 2068 should be available through larger retailers and mail order houses with a suggested retail price of \$199.95. However, it has already been scheduled for advertising in one major mail-order catalog for

*By Fred Blechman*

\$148.32. Although in June, a T/S 2048 was also announced (with 16K RAM instead of 48K, and for \$50 less), it appears that only the T/S 2068 will be available at this time.

This report is based on a pre-production T/S 2068 operating with a production Timex Sinclair 2040 Personal Printer and an inexpensive cassette tape recorder. A standard black-and-white 12" TV receiver and a 5" color TV/video monitor were used as displays.

**General Description.** The T/S 2068 is contained in a light gray plastic case whose upper surface is painted with a dull aluminum finish. The full-size keyboard uses light gray keys with easily read black printing on the keys, and clear black "keywords" above and below most keys. It's a smart-looking package. It's also relatively large: almost 15" wide, 7½" deep, and almost 2" high. It weighs about four pounds.

In a drastic departure from the Spectrum physical design, Timex upgraded the Spectrum's rubbery, closely spaced "chiclet" keys with "hard" typewriter-like keys—the same as used on the Brother EP-20 Personal Electronic Typewriter. The keyboard is standard typewriter size and the full-travel keys have the standard QWERTY layout. An indication of the care given to detail is that the F and J keys have raised finger-tip sensitive dots, since these are the "home" keys for touch typists. Several of the keys in the top row are used to specify display colors, and these have colored legends above them in the color they control, which is a very handy feature.

There are 42 keys that include 36 alphanumeric and symbol keys, a SPACE bar and a CAPS SHIFT key on each end of the keyboard, with automatic repeat.

Most of the keys do multiple duty, since single-keyword entry is provided for over 150 BASIC commands and statements. Most keys perform five different functions, while seven keys have six functions. Functions are identified by one of six different letters that appear within the block cursor.

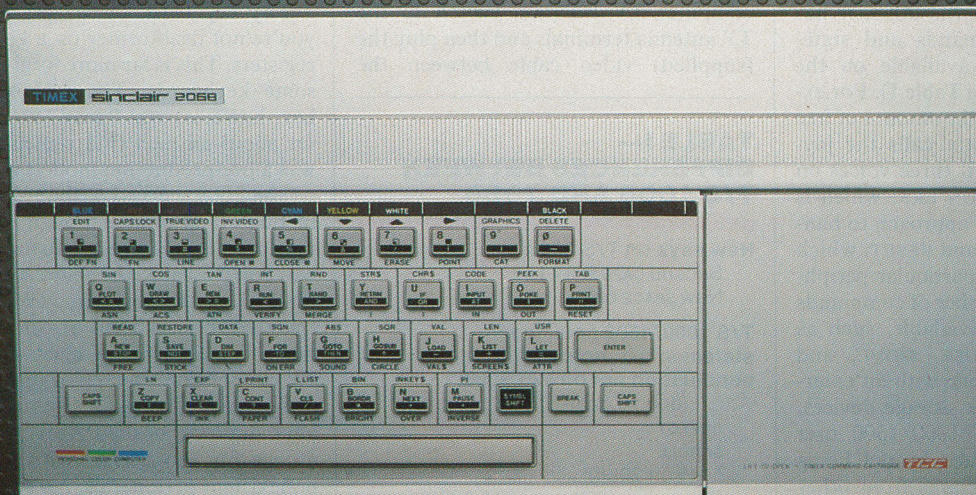
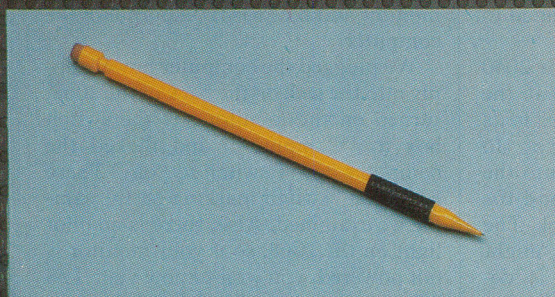
Eight of the keys directly provide 16 graphic blocks; and 21 high-resolution, 64-pixel, user-defined characters can be programmed for individual keys. Many special symbols are available, such as a copyright symbol, an "at" sign, an English "pound" sign, and much to the joy of T/S 1000/1500 owners, an exclamation point!

On the left side of the computer there's an on-off switch and an Atari-standard 9-pin joystick connector. There's another identical joystick port on the right side. On the back, a snap-off cover reveals a 64-finger gold-plated card edge—the main computer bus. Five jacks are clearly marked along the back side of the T/S 2068: MONITOR (yes, direct video for a monitor), EAR, MIC, POWER, and TV. Underneath there is a small switch to select Channel 2 or 3 when using a TV receiver for the display.

The T/S 2068 uses the 8-bit Z80A microprocessor that can directly address 64K bytes of memory. However, utilizing a special Timex-designed system and a "function dispatcher," up to 256 "banks" of 64K memory can be utilized in 8K "chunks," for a total of over 16 megabytes (but no more than 64K at any one time.) The 24K ROM (16K plus a bank-switched 8K) includes a powerful expanded BASIC interpreter and operating system, and 48K of RAM is built-in and accessible for user programs.

Timex, and probably others, will offer "Command Cartridges," 2½" square plastic cases that plug into an interface built into the upper right surface and are accessible via a lift-up door on





## People who have 1000s will find many things they complained about have been corrected in the T/S 2068.

the T/S 2068. The cartridges contain pre-programmed ROM, with their own operating system included; the T/S 2068 ROM can be switched out to allow more cartridge capacity. As of this writing, some 25 titles covering games, utilities, and business/home software are available.

Cartridges only need to be inserted into the computer and don't require loading (which is necessary when using cassette tapes). They operate in the same manner as cartridges for video game machines, like the Atari VCS, ColecoVision, Intellivision, and others.

The display can be programmed to show various "attributes" (characteristics) for each character space in most display "modes." Eight colors are avail-

able for PAPER (background), INK (printing) and BORDER (outside the regular display area). Also, there are two BRIGHTNESS levels for each color, and FLASHING is available for each character space. INVERSE VIDEO provides for a switching of PAPER and INK colors in any character space. All this provides the capability for a variety of special effects.

Not only that, the T/S 2068 has *four* display modes. (The Spectrum has only one!) The Normal Display Mode 1 provides 22 rows of 32 characters on a line available to the user, plus two more lines the computer uses for line entry, editing and status reports. This same mode offers 16 character-space graphic blocks (four sections to each block) or

256 "pixels" (picture elements or "dots") on a line, with 176 lines of pixels from top to bottom.

Display Mode 2 is the 64-Column Mode, with 22 rows of 64 characters on a line, and a pixel resolution of 512 by 176. The 64 characters on each line, however, reside on two memory "pages" of 32 characters each, and appear on the screen in alternate spaces. Therefore, it takes special programming (probably machine language) to show 64-character text on the screen. Such software is in the design phase at the moment.

Display Mode 3 is a second "normal" screen, like Mode 1. By switching rapidly between Modes 1 and 3 you can produce animation.



The fourth, Display Mode 4, is called "ultra-high color resolution." It has the same character and pixel resolution as Mode 1 (32 character lines, 256 pixels on a line), but with an important difference. Each character space contains eight rows of eight pixels each. In this mode each row of pixels in each character space can be assigned various color parameters (INK, PAPER, BRIGHTNESS and FLASHING). This allows great flexibility in color mixing and other visual effects—but definitely requires sophisticated programming.

The language used in the T/S 2068 is Sinclair Expanded BASIC, sometimes referred to as Spectrum BASIC, with a number of additional commands not found on the Spectrum. To give you an idea of the power of the 2068, it has more than 50 commands and statements that are not available on the Timex 1000/1500 (see Table I). For example, FREE displays the amount of free RAM space left; STICK calls the joysticks; SOUND can call three voices on the built-in speaker; ON ERR, which is similar to Applesoft's approach to handling internal errors; and RESET, which is used to initialize a particular peripheral. It even has a number of commands for devices not yet available, such as FORMAT, OPEN, CLOSE, MOVE, and ERASE, which will work with an external disk and disk-like storage devices. For the former T/S 1000/1500 user who has been frustrated by not being able to translate programs from other computers, these new commands (such as READ, DATA, RESTORE, and others) should make the task feasible.

The T/S 2068 has four "voices" produced through a built-in speaker, with three of the voices programmable in eight octaves. On those three voice channels, the SOUND command allows specifying tone, duration, amplitude, and various envelope parameters. The single-channel BEEP command allows specifying any of 130 semitones and a duration. The Spectrum, incidentally, has only the BEEP command directed to a very small sounding device.

Eight-position industry-standard (Atari compatible) joysticks are used with the STICK command. In addition to game control, creative programmers will likely use these joysticks for graphic art generation, as well as cursor control in word-processing, data-base, and spreadsheet programs.

**User Comments.** The T/S 2068 comes with all the necessary accessories to get it up and running, except the display. The very detailed over-300 page User Manual—in color, with many, many screen displays—really holds your hand through the early stages of getting the

system together and learning how to use the confusing keyboard. The User Manual is basically a reference and getting-started book. It describes the use of most commands, but is not intended to teach programming.

We plugged the Timex Sinclair 2040 Personal Printer onto the bus at the back of the 2068, and then plugged in its 24-V ac power supply. (Be sure *not* to plug the printer power supply into the computer, since the computer and the printer have exactly the same jack. The printer power supply is ac and might damage the computer, which is designed for a dc input.) We used both a black and white TV receiver and a color monitor for displays. If you're using a TV receiver, connect the (supplied) computer/TV isolation switch to the TV antenna terminals and then plug the (supplied) video cable between the

switch and the TV output jack on the rear apron of the computer. If you're using an NTSC or black-and-white monitor, plug the video cable between the monitor and the MONITOR output of the computer.

We plugged the computer power supply into the jack on the back of the 2068, turned on the monitor, set the switch box to "Computer," and flicked the computer power switch to "on." There is no "on" switch marking on the sample we examined. Also, there is no pilot light on the 2068, so if your monitor is not powered, you won't know your T/S 2068 is on. A large black block appears momentarily on screen, followed by a screen clear and two copyright notices: Timex and Sinclair. So far, so good.

The keyboard has a soft touch. If you're not dead-center on a key, it still registers. This is far more forgiving than some keyboards. The 6"-long SPACE key, however, was "dead" at each end for about an inch (but remember, this was a pre-production model).

The 2068 worked without any flaws in black and white, though the color produced by the pre-production model was "off." That is, the colors were not as marked on the keyboard. (We've been told that this has been corrected on production units.) On a black-and-white TV or monitor, each color appears as a different shade of gray. We tried all the keys and most of the BASIC functions, except for those used with presently nonexistent peripherals. No surprises.

We used an inexpensive cassette tape recorder to SAVE and LOAD programs. Timex even supplies a cable with dual plugs on both ends for the EAR and MIC jacks on the computer and recorder. A costly cassette recorder is not needed, therefore, and may not even work as well as a "cheapie."

Cassette operation (1500 baud, or about 150 characters per second) was very reliable with a broad range of loading volume. We loaded a 3373-byte BASIC program in about 24 seconds, including about 4 seconds for the program "leader." Programs are assigned filenames when saved, and the program name appears on the screen as the program loads. Striped moving bars on the screen confirm loading and saving.

The printer COPY command duplicated every ink dot on the screen—32 characters or 256 pixels on a line—including high-resolution graphics. Listings also appeared the same as on the screen. On those screen displays with color, the printer only showed the ink color dots, and totally ignored paper color dots.

The printer output was sharp, fast and quiet, and photocopied very well. The printer uses 4¼" wide thermal paper, and you can make only one copy at

**TABLE I—  
DIFFERENCES BETWEEN  
T/S 1000 AND 2068**

**New keys on T/S 2068:**

Second CAPS SHIFT key  
New SPACE bar

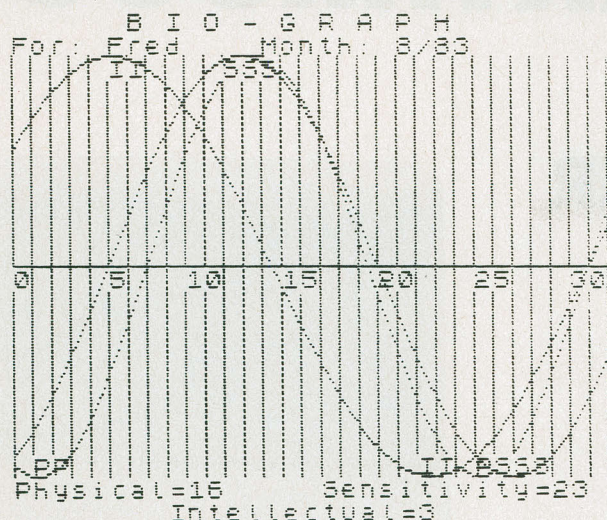
**T/S 1000/1500 commands/  
statements/functions and  
punctuation not on T/S 2068:**

" " (double quotes)  
UNPLOT  
SCROLL  
\*\* (▲ on 2068)  
"S" cursor ("?" cursor on 2068)  
"F" cursor ("E" cursor on 2068)  
Function key

**T/S 2068 commands/  
statements/functions and  
punctuation not on T/S 1000/1500:**

CAPS LOCK	BORDER
TRUE VIDEO	FLASH
INV. VIDEO	BRIGHT
DEF FN	OVER
FN	INVERSE
LINE	CAPS SHIFT
OPEN #	READ
CLOSE #	DATA
Merge	RESTORE
ERASE	BIN
POINT	DRAW
CAT	[ (left bracket)
FORMAT	] (right bracket)
VERIFY	{ (Left brace)
Merge	} (Right brace)
IN	© (Copyright sign)
OUT	\ (Backslash)
RESET	@ (at sign)
FREE	↑ (** on 1000/1500)
STICK	#
ON ERR	!
SOUND	%
CIRCLE	&
SCREEN\$	' (apostrophe)
ATTR	_ (underline)
BEEP	"E" cursor
INK	"C" cursor
PAPER	"?" cursor





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1525 Main St.  
Anytown  
CA 93545

*Samples from the author's  
upcoming book, "Timex 2000  
Beginner/Intermediate Guide," published  
by Howard W. Sams, Book #22225*

### Samples of Timex Sinclair 2040 Printer output.

a time. However, for word processing or any serious use, or to reproduce the 64-character display mode, you'll want to connect a standard 80-column printer and print on regular paper, with multi-copy capability. Timex, at this writing, only offers the 2040 Printer, but is said to be working on an 80-column printer. Other companies have designed printer interfaces for use with the Timex 1000 and 1500, allowing the use of Centronics parallel printers. It can be expected that this will also be done for the T/S 2068.

We tried the BEEP and SOUND commands produced through the small built-in speaker, and were even able to play simple tunes. The SOUND command is quite complicated, since it can produce three voices with several parameters. The BEEP command, however, is simple to use. In both cases, we found that by connecting an amplifier to the computer output marked MIC (which normally goes to the cassette MIC input) we were able to get plenty of sound or beep. While the BEEP command has no volume control; the command for SOUND does.

We did not test the joystick or cartridge capabilities, or the other three display modes, and we did not try the RGB monitor output available on the 64-pin bus.

Out of curiosity, we checked the power consumption of the computer, since the power supply was marked 17.5 V dc at 1 ampere, and this would amount to 17.5 watts—higher than we would expect. In actual use, however, the power supply was delivering only 215 milliamperes at 21 V dc, or less than five watts. Unlike the Spectrum, both the power supply and the computer hardly warmed up! Timex has really tamed the

heat problem that plagued the Spectrum.

**Conclusions.** Except for the "dead-ended" SPACE key and the off-colors (both of which can be attributed to the fact this was a pre-production model), I was very impressed with the performance of the new 2068, as well as the potential of those things we *didn't* test at this time (the 64-character mode, animated and ultra-high resolution displays, the cartridge and joysticks, the complex sounds, and the ability to memory-bank select over 16 megabytes). As software wizards produce programs to access these features, we'll start using them. About the only things we'd like to see added are a power-on indicator, a remote control for the recorder, and distinctively different power-input jacks for the computer and the printer.

Although most BASIC programs written in England for the Spectrum will LOAD and RUN in the T/S 2068, most machine-language programs will not. However, at least one U.S. company, SoftSync (14 E. 34th St., NY, NY 10016), is converting Spectrum programs for the T/S 2068. It also appears that Timex will be offering about 25 programs for the T/S 2068 when it is expected to hit the marketplace around the end of October.

As for the future of the T/S 2068, Timex has already announced plans to produce a telephone "modem" for the computers. With appropriate programming, this will enable communication, information exchange, and even the capability to "upload" or "download" programs. You'll be able to connect to "bulletin boards" and large networks and data bases like CompuServe and

The Source, leaving messages (electronic mail) or carrying on real-time exchanges in a conference, or on a CB simulation.

We can also expect some programming and hardware geniuses to produce "light pens" (to draw directly on, or to select items from the screen), "bit pads" (the same thing on a flat surface in front of you), "mice" (cursor positioning devices), and other not-yet-thought-about devices for the T/S 2068. Certainly, the software at first will be games, games, and more games, followed by word-processing and personal software.

The T/S-2068 is a solid learning/home computer. Its cost is not prohibitive for these purposes, assuming one is going to use an already-owned cassette recorder and TV receiver. Of course, a horde of software and hardware additions will take time to develop in the marketplace, a shortcoming that most newly introduced computers share. This Timex machine has a head start in this respect, however, since there are so many Spectrum machine-language programs in the U.K. that can be easily converted to operate on the T/S-2068, as well as more hardware.

Since the T/S does not use a typical memory map scheme, using ultra-high resolution color graphics and the 64-character mode cannot easily be taken advantage of without using advanced programming techniques. This was not addressed in the machine's manual.

Moving out of the very-low-priced T/S-1000 class into the modest category throws the new T/S-2068 into an area where there are a handful of tough, entrenched competitors. However, its nice attributes make it deserving of buying consideration in its class. ◇

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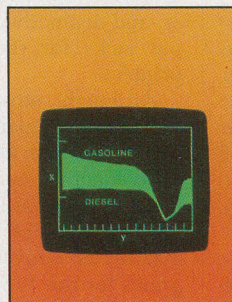
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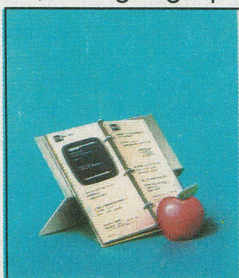


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# Matchmaker! Matchmaker!

COMPUTER interfacing can be very confusing and frustrating. Although the two "standard" interfaces, "Centronics" *parallel* and "RS-232" *serial*, are supposed to allow simple plug-in connections, in reality this is often not the case. Frequently, a manufacturer adds features that don't fit the definitions of a given standard. The interfaces are really "conventions" that have come to be frequently used rather than "standards," which means that you can do almost anything you want and still call it "compatible."

In an effort to eliminate some confusion, several manufacturers have designed their equipment with the flexibility to deal with the plethora of "standards." Others have taken a different approach and provided a *real* standard interface, along with the peripherals to work with it. I am thinking particularly of Commodore, which has provided an IEEE-488 (Hewlett-Packard GPIB) interface since the introduction of its first computer back in

## Interfacing with Parallel and Serial Ports

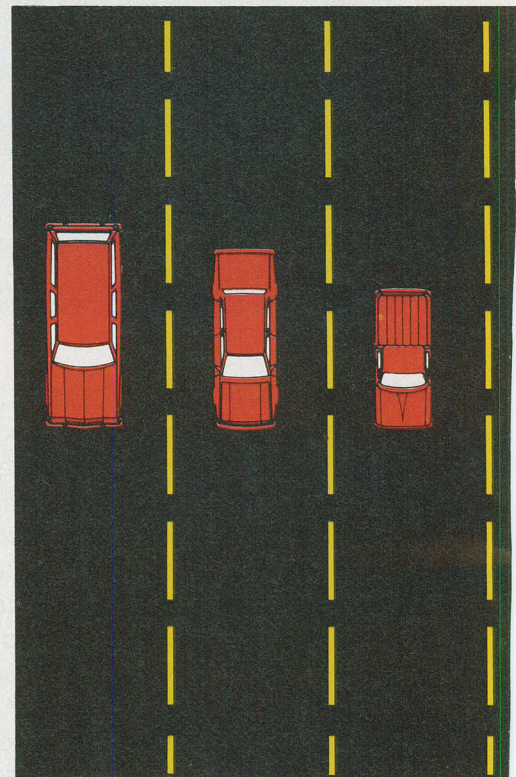
By Alex Marx

the 1970s. This interface is rigidly defined right down to the type of wire to be used.

Unfortunately, it is a costly standard. The connectors and cables are expensive (up to \$70 for a six-foot cable) and very few other computer or peripheral manufacturers have adopted the system. The IEEE-488 interface was designed primarily to connect test and lab equipment to dedicated controllers, and it is in this sphere that it has been most successful. Since there have been few personal-computer peripherals to adopt this system, several companies have sprung up to adapt the IEEE-488 to the more prevalent Centronics and RS-232 interfaces.

**The Parallel Interface.** The parallel printer interface is often called a Centronics interface, after the company that developed it for its line of printers. The specifications for this interface call for eight unidirectional data lines (or wires), three handshake lines, several control and miscellaneous signal lines, and signal-return and ground lines.

The "standard" Centronics connector is a 36-pin D connector such as the Amphenol (DDK) 57-30360. The mating female connector on the printer is an Amphenol (DDK) 57-40360 type. These connectors are produced by many manufacturers and are available for ribbon cable as well as for multi-conductor cable.

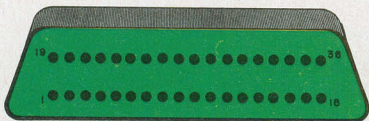


The parallel-communications concept can be described in terms of a short eight-lane highway, supporting only one-way travel. At the start is a roadblock to control access and at the far end is a toll booth. To avoid congestion on the highway, only eight vehicles are allowed to cross at a time. All the vehicles must travel abreast of one another, or in parallel. To control the traffic flow, there are several signals used. At both ends of the highway there are bells: the roadblock end can ring the toll booth's bell and vice versa. At the roadblock end, there is also a red-green traffic signal across all eight lanes. This light is controlled from the toll booth, or sending, end. At each end there is a man in charge of the bells and lights.

To start the whole thing going, the receiving end makes sure it's ready and

PIN 1 STROBE	19 STROBE	
2 DATA 1	20 DATA 1	
3 DATA 2	21 DATA 2	
4 DATA 3	22 DATA 3	
5 DATA 4	23 DATA 4	
6 DATA 5	24 DATA 5	
7 DATA 6	25 DATA 6	
8 DATA 7	26 DATA 7	
9 DATA 8	27 DATA 8	
10 ACK	28 ACK	
11 BUSY	29 BUSY	
12 PE	30 INIT	
13 SLCT	31 INIT	
14 ±OV	32 FAULT	
15 OSCXT*	33 NC	
16 ±OV	34 LINE COUNT PULSE*	
17 CHASSIS GND	35 RETURN	
18 +5V	36 NC	

\*GENERALLY NOT USED TODAY



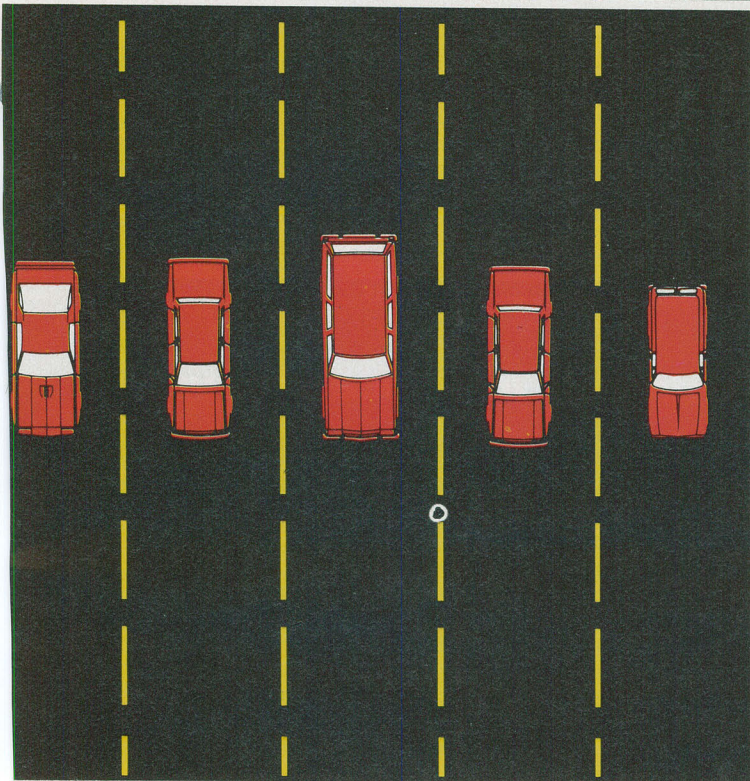
PRINTER CONNECTORS: AMPHENOL (DDK) 57-40360  
CABLE CONNECTORS: AMPHENOL (DDK) 57-30360

Fig. 1. Pinout of a Centronics parallel connector.



then turns the traffic light green. Eight vehicles enter the highway and, when they reach the toll booths, the man at the roadblock end pulls his cord to ring the bell at the booths. This causes the toll keepers to look up from their newspapers and collect the tolls. At the same time, the controller at the toll booth turns the roadblock's traffic light red and also rings the bell at that end. This acknowledges the receipt of eight tolls. When the eight vehicles have left the booths, he turns the light green and eight more vehicles roar across to the other side and the cycle repeats. If one

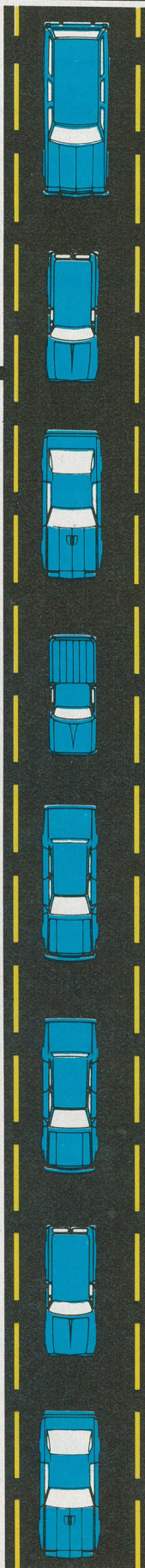
►  
**The serial interface is analogous to a single-lane road with each car following another at rigid time intervals**



of the toll clerks runs out of change and has to fetch more, the light is kept red to tell the sending side that the clerks are busy and traffic should be held up.

The idea of lights and bells is called *handshaking*. It is simply a method for one device to tell the other what it is doing. In the foregoing analogy, it showed when the toll booths were ready to receive more vehicles. In a printer, it would be used to tell the computer when it was ready to receive another character to print. The reason handshaking is necessary is that the printer, being a mechanical device, is much slower than the computer. You might reason that you could have the computer send out characters slowly enough for the printer to keep up. But, not only would this be inefficient, you couldn't take into account the fact that a printer takes longer to do

▲  
**The parallel concept can be thought of as a short strip of eight-lane highway with eight cars starting at the same time**



a carriage return and line feed than it does to print a character. Also, you could not tell if the printer had run out of paper or if it were even turned on! Handshaking allows the computer to send characters as fast as the printer can accept them, as well as keep track of problems like running out of paper.

In the Centronics interface, the signal represented by the traffic light is called **BUSY** and is controlled by the printer. The printer uses it to tell the computer when it is busy, as when it is in the middle of printing a character or tied up doing a carriage return. The bell at the

roadblock end is called **Acknowledge** or **ACK**. It is used to indicate when the printer has accepted the last character sent. The bell at the toll booth is called **Strobe** or **STB**. It is sent by the computer to tell the printer that there is a character ready to read on the cable. Without this signal, the printer cannot tell when a new character has been sent.

The true Centronics interface defines several more control signals, many of which are little used today. **SELECT** is used to tell the computer that the printer is on-line, or able to accept data through the interface (as opposed to accepting data from a panel switch or keyboard). Error conditions are also signaled by quite a few lines. These include **Printer Error**, or **PE**. It is used to indicate when the printer has malfunctioned in some way, as in the case of ribbon jam. **FAULT** or **ERROR** indicates some type of abnormal condition like a **PE** or the cover being open. The only reason I can see for all these error lines is to allow for intelligent interface software to tell the user, via the computer's display, the exact error condition. However, in most implementations today the **BUSY** signal is used to indicate all fault conditions. A fault condition is usually accompanied by the computer's "hanging," while waiting for the **BUSY** signal to disappear. A complete pin-out of a Centronics connector is shown in Fig. 1.

The voltage levels in the Centronics interface that define the high and low (or 1 and 0, yes and no, or on and off) control levels are the same as those used in the integrated circuits in microcomputers. In engineering jargon these are called *TTL levels*. A *high* is defined as being between 2.5 and 5.0 volts and a *low* is between 0 and 0.7 volts. As an aid to the user, timing charts are usually drawn to show the various signal levels and the timing relationships among them. Such a chart is shown in Fig. 2. The vertical axis shows time, and the horizontal axis voltage.

Note that the **STROBE** signal is true when it is low. This means that the



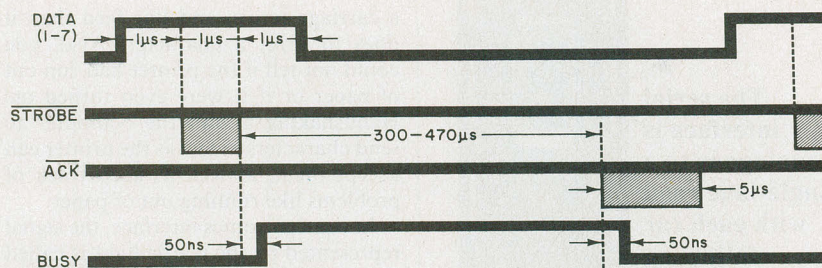


Fig. 2. Timing chart for a Centronics parallel interface.

printer reads data when the STROBE line changes from high to low. On the other hand, the BUSY signal indicates a busy condition when it goes from low to high. This is called *positive true*. The STROBE signal is an example of *negative true*. To indicate a negative true a bar is placed above the signal name, i.e.  $\overline{\text{STROBE}}$  and  $\overline{\text{ACK}}$ .

The Data lines are represented by only one line in Fig. 2, as the timing of the data is more important than what data are sent. The time increments are

ized handshaking. To make it work requires setting it up to generate STROBE and accept BUSY. That requires not only the 3P+S but support software as well. A friend's S-100 system has a Godbout Interfacer 4 board, which has a Centronics type interface that supports full handshaking including a number of error and signal lines. Because the hardware supports all these functions, the software is simpler.

**Do It Yourself.** Armed with the infor-

the cable six feet or shorter. If you are trying to get a system running with long cables, make sure you get it working with a short cable first and then try the longer length. Many hours can be saved with this method. (Listen to the voice of experience!)

Using the data sheets, verify with the continuity tester that the wires go to the correct pins on both ends of the cable. Also check that none of the adjacent pins (side to side as well as front to back) are shorted together. This is a common problem with the newer clamp-on connectors for ribbon cable.

Unless one end of the interface specifically requires it, do not connect any pin with power on it to any other pin. Many printers have a +5-volt pin; I never connect anything to this pin. One bad connection or an accidental short can wreak havoc.

Printers generally have many pins labeled RETURN or 0 VOLT, and GROUND (GND), FRAME or PROTECTIVE GROUND. Always connect at least one



*"I prefer the Centronics interface because it*

in millionths of a second. The action is as follows. The computer puts data on the data lines and approximately 1 μs later causes the STROBE line to go low. The printer then makes the BUSY line true. When the printer has processed the character it takes the ACK line low, and a short time later releases the BUSY line. Shortly after that the ACK line is also released. Note how this compares to the toll booth and bell analogy.

Computer people are always looking for ways to simplify things, and it did not take them long to figure out that you do not have to use the ACK signal. Instead, if the computer just watches the BUSY line, it can determine when the printer is ready for another character. If the BUSY line is low, the printer can accept data. In fact, while printing, most computers just sit in a software loop doing nothing but watching the BUSY line. And since BUSY also indicates when the printer is off line, and error conditions, it eliminates hooking up the other signal lines! Most parallel interfaces today only use the STROBE and BUSY lines for handshaking. This is especially true in the Apple computers.

In the S-100 marketplace both methods are used. In fact, my system uses an old Processor Technology 3P+S board that has parallel outputs with general-

mation presented, it should be a simple matter for you to connect a parallel-interfaced printer and computer. Every day that task becomes simpler as more and more manufacturers strive for compatibility. However, problems can still arise. The minimum equipment you will need to get everything running is the documentation for both the printer's connections and the computer's connections and an ohmmeter or other sort of continuity testing device.

Most parallel-interfaced devices are limited to having about six feet of cable between them. The limitation is due to several factors, but it can be stretched. I have successfully run cables 15 feet or more. The best bet, though, is to keep

RETURN or 0 VOLT and one GROUND, FRAME or PROTECTIVE GROUND. The RETURNS and 0 VOLTS are the return connections for the low-voltage data and signal wires. You can never connect too many of these together—in fact, the more the better. The GROUND, FRAME or PROTECTIVE GROUND is a connection to the metal chassis of the printer. It is used for safety purposes, both yours and the equipment's, to make sure that both the printer and computer are at the same electrical potential in case of some sort of error or accident at the 110-volt ac power connections. *Do not* use these connections for the low voltage signal returns. A missing ground connection or similar problem can severely damage

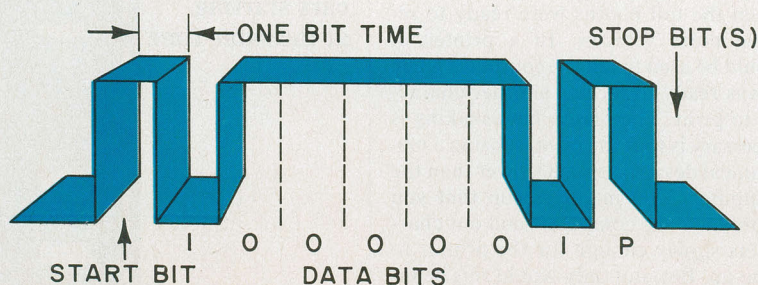


Fig. 3. Diagram of a typical serial data transmission.



your equipment, as well as present a shock hazard.

If all your connections seem proper but nothing works, it's time to check signal polarities. Though most printers today use positive true DATA, negative true STROBE, positive true BUSY and negative true ACK, don't take it for granted. Some printers and computers have switches or jumper wires to allow the polarities to be changed. Consult the manuals for as much detail as you can find and keep a record of your work. Make sure you cycle the printer off and on between trials since it could be "hung up" from an incorrect setup. Look for clues in the operation of the printer. For example, if the printer prints but starts dropping characters after a while, it is a sure sign that the handshaking is fouled up. Check the BUSY and ACK lines.

With a little patience and some sleuthing you should be able to get results. If all else fails, make sure the printer and computer interfaces are working. Other problems can include

The RS-232 serial communications protocol was originally developed to connect a data terminal to a modem. Because computing was limited to mainframes and therefore expensive, users were generally connected via a terminal and modem to the often remote mainframe. The connection between the modem and the computer was frequently handled via dedicated lines, though telephone lines were a popular choice for all but the shortest distances. The RS-232 protocol was designed to connect Data Terminal Equipment (DTE), which was a terminal, to Data Communications Equipment (DCE), which was a modem.

A modem converts digital signals into tones that can be sent along relatively inexpensive telephone lines. The price you pay for using the cheap lines is speed. Modems typically can send 30 characters per second (cps) as opposed to over 100,000 cps for a simple parallel interface. However, modems are not limited by distance, with communica-

tions possible over many thousands of miles.

Serial interfaces work by sending each bit of the transmitted character one after the other, or serially. The process is analogous to a single-lane road where each car must follow the other. The bits are sent at rigid time intervals. The transmission speed is called the baud rate and is equivalent to bits per second. Standard baud rates include 75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, and 19,200. Modems generally work at 300 baud but some also work at 1200 baud.

A high bit, or 1, is represented by a voltage between -5 and -25 V. A low bit, or 0, is represented by a voltage between +5 and +25 V. This negative true logic only applies to the data line; the handshaking lines which use the same voltage levels are positive true. The higher voltages and slower speeds of the serial interface permit longer cables—up to 50 feet for most applications.

When no data is being sent, the

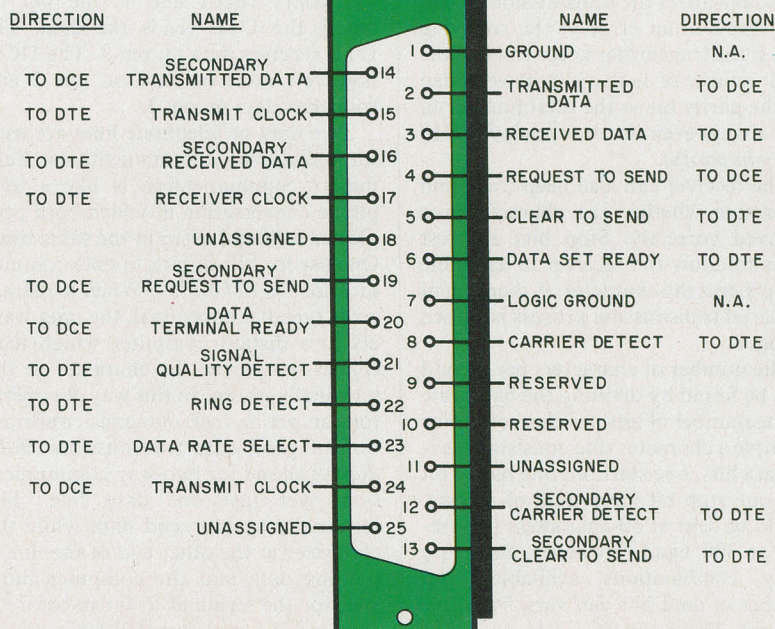
**works the first time ,over 90% of the time."**



timing (does the STROBE signal last long enough?) as well as software bugs. Many computers send seven bits of data rather than eight. Simple printers may only have seven data lines while others may use the eighth bit for special functions like graphics. If the computer's software does not take into account the eighth bit, "interesting" effects can occur. Often just connecting the eighth bit on the printer side to a RETURN or 0 VOLT line may cure the problem.

Although all this sounds complicated, it really is not. I prefer the Centronics interface because it works the first time more than 90% of the time. And compared to the intricacies of the RS-232 serial interface, the parallel is almost child's play. However, if you need longer cable lengths than a parallel interface allows, or if you are working with a modem or similar piece of equipment, then RS-232 is inevitable.

**The RS-232 Serial Interface.** If I sound a little hostile towards RS-232 it's because it has been so corrupted over the years that a clear understanding of its subtleties is impossible. Although I have worked with it for years and it can be simple and efficient, I still prefer the Centronics interface because it is basically unchanged.



**Fig. 4. Pinout of an RS-232 serial connector.**



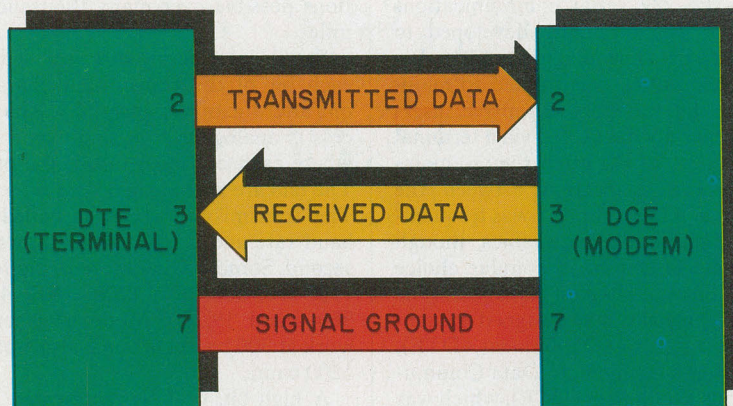


Fig. 5. The basic RS-232 connection uses only three lines.

dataline sits at a 1 condition. To announce the start of a character transmission a *start bit* is sent. This brings the data line to 0 and tells the receiving end that there is information following. After all the data bits have been transmit-

up the same way; otherwise errors will result.

A diagram of an RS-232 connector is shown in Fig. 4. The connector is a standard DB-25, which is available in many styles, including clamp-on for ribbon

the scope of this article. However, the lines of interest to the average computer user are TRANSMITTED DATA, RECEIVED DATA, EARTH GROUND, LOGIC GROUND (RETURN), REQUEST TO SEND (RTS), CLEAR TO SEND (CTS), DATA SET READY (DSR), CARRIER DETECT (CD) and DATA TERMINAL READY (DTR). Although this may seem like a handful, only a few of these lines are used in actual practice.

The simplest RS-232 connection uses only three lines, as illustrated in Fig. 5. This is fine for low-speed applications, or where both devices can keep up with each other.

More sophisticated applications can use this system with software handshaking, perhaps using the XON/XOFF protocol. The two devices watch each other's transmissions for two special control characters: XON which is ASCII 16 (Control-Q) and XOFF which is ASCII 18 (Control-S). When the transmitter gets an XOFF from the receiver, it stops and waits until it receives the XON



**"If you need longer cable lengths than a parallel**

ted, a *parity bit* and one or more *stop bits* are sent to mark the end of the character.

Parity is a form of error checking. Noise can affect the transmission of a bit and result in an error at the receiving end. If the transmitter keeps track of the total number of 1s in a character, it can set the parity bit so the total number of 1s is always even (for *even parity*) or odd (for *odd parity*).

The receiver can also keep track and determine whether the character was received correctly. Stop bits are rest times to allow the receiver to assemble and process the character. A diagram of the serial transmission process is shown in Fig. 3.

The number of characters per second may be found by dividing the baud rate by the number of bits per character. For example a character that consists of seven data bits, one start bit, one parity bit and one stop bit for a total of 10 bits, would be sent at 30 characters per second at 300 baud. However, there are many combinations available. The number of data bits can vary from five to eight. There can be 1, 1½ or 2 stop bits, and the parity bit may or may not be used. All these factors are important in setting up the interface. The transmitting and receiving ends must be set

up the same way; otherwise errors will result. A diagram of an RS-232 connector is shown in Fig. 4. The connector is a standard DB-25, which is available in many styles, including clamp-on for ribbon

cable. The DTE and DCE are both equipped with female connectors. All signal designations are from the perspective of the DTE. Pin 2 is called TRANSMIT DATA and is the pin on which the DTE sends the data. The DTE receives data on pin 3. The DCE, however, receives data on pin 2 and transmits data on pin 3. Two data or telephone lines are used for *full-duplex* communications. Full-duplex communication is like a telephone conversation in which both people can talk and listen at the same time. One use for full-duplex in data communications is *Echo-Plex*. When a character is typed at a terminal, the data travels to a distant computer which then echoes or returns the character to the terminal's screen. In this way, an operator can get an instantaneous confirmation of good data transmission. *Half-duplex* allows for two-way communication over just one data line. The terminal may not send data while the computer at the other end of the line is sending data and the computer must wait for the terminal to finish before it can send. An analogy is CB radio, where only one person can talk at a time.

You will note from Fig. 4 that there are a number of signal and handshaking lines. What all those lines do is beyond

character to continue. This form of handshaking requires intelligence on both ends to process the XON/XOFF characters. If it is available it should be used because it simplifies the number of connections required and eliminates having to worry about which handshaking lines to use.

The RS-232 interface was never meant for use with printers or computers. Computer interfaces and printers can be configured as DTE or DCE at the discretion of the manufacturer. If your computer's interface is configured as DCE (a common occurrence) and you try to hook it up to a modem (also DCE), they won't talk to each other. The solution to this problem is to make a null modem adaptor. This is a short cable with two connectors: one mates with the existing cable and the other plugs into the modem. The two connectors are cross wired so that the proper signals connect: that is, pin 2 to pin 3, pin 3 to pin 2, etc. A diagram of a null modem cable is shown in Fig. 6.

Printers present a special problem because the RS-232 handshaking lines are meant to deal with terminals and modems. The problem gets really serious at speeds higher than 300 baud. Most printers can handle 30 characters per second, which is roughly equivalent



to 300 baud, without losing characters. This is especially true of printers with internal buffers that can store the additional characters that would back up when the printer does a carriage return. That might lead you to believe that handshaking wouldn't be necessary at slow baud rates; and it wouldn't if all you were doing were printing. But if you need to stop the printer to readjust the paper, change a ribbon or answer the phone, the computer will still send characters, blissfully unaware that the printer stopped five minutes ago.

With all the handshake lines available in the RS-232 protocol, you would think that there would be a solution to this problem. Unfortunately, there is not a single line set aside for the purpose because this problem does not exist between a terminal and modem. If we examine the signals carefully, we find two that look like they might do the job: pin 4, REQUEST TO SEND (RTS) and pin 5, CLEAR TO SEND (CTS). They certainly sound like they are a perfect hand-

shaking pair. The problem is that they are really only half a handshake. manufacturers try using different pins such as DTR or DSR, or a combination of several signals. There is no guarantee that a particular scheme will work with any interface that expects true RS-232 handshaking. The situation is getting better, however, because many manufacturers are letting their systems work outside the definitions of the protocol.

You can see why I prefer to use the Centronics parallel interface. There are times, of course, when the Centronics solution is not the best way to go, such as when there are distances over six feet involved, or when the equipment in question only is available with a serial interface. For those times here are some handy tips.

**Doing It Yourself.** Get all the information you can about the equipment. You will need to know how to modify baud rates, parity, and data word and stop bit lengths for both pieces of equipment. Also try to find out what kind of handshaking is required and whether

connections will have to be crossed, pin 2 to pin 3 and pin 3 to pin 2. If your documentation spells out the connections, then so much the better. This is a good point to stop and try out what you have done so far.

Set both pieces of equipment to a slow baud rate—300 baud is fine. Most default setups call for seven data bits, no parity, one start bit and two stop bits. Connect the equipment and try sending data. If the transmitter seems to be sending but there is no response from the receiver, try reversing the connections to pins 2 and 3 at one end. If the transmitter locks up or if the receiver loses characters, then handshaking is at fault. Here you are going to have to rely on the manuals and experimentation. Some pairs of devices may have several handshaking lines at one end but only one at the other. In this case you can fool the multi-handshake line by having it handshake with itself by connecting complementary signals on the same connector. Two common examples of

**interface allows, the RS-232 is inevitable."**



shaking pair. The problem is that they are really only half a handshake.

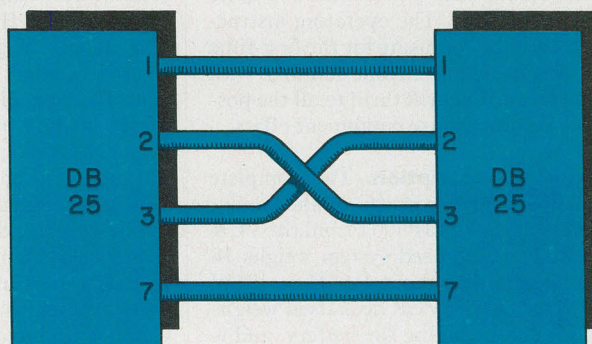
The DTE asserts (makes true) the REQUEST TO SEND line when it has data to send. The DCE acknowledges this, when it is ready, by asserting the CTS line. When the DTE sees the CTS it starts to send data. However, the DCE may not un-assert the CTS line any time

the equipment is configured to be DCE or DTE. A DTE will send data on pin 2 and receive on pin 3, while a DCE sends on pin 3 and receives on pin 2. Be aware that in both cases pin 2 is called TRANSMIT DATA and pin 3 is RECEIVE DATA because all signal definitions are from the perspective of the DTE. Many manuals have arrows denoting data flow; for

this are to connect the RTS (pin 4) back to the adjacent CTS (pin 5), and to connect DTR (pin 20) to DSR (pin 6) and sometimes, additionally, to CD (pin 8).

With perseverance and determination you should be successful. Once the interface is working, you can bring it up to full speed. Most printer interfaces will go to 1200 baud, and most terminals to 9600 or 19,200 baud.

**Fig. 6. A null modem cable reverses the leads to pins 2 and 3.**



it wishes; it must wait for the RTS line to go false first. Since only the DTE can control the data flow, we are still at square one.

Many printer manufacturers use pins 4 and 5 anyway. Since a printer is not defined in the specification of the protocol, what difference does it make if you don't follow the strict definitions? Other

example, if the arrow points away from pin 2, then the system is DTE.

The first step is to connect pin 1 to pin 1 and pin 7 to pin 7 on both connectors. These are FRAME GROUND and SIGNAL GROUND (RETURN), respectively. For safety's sake make sure both are connected. The next set of pins is the data lines, pins 2 and 3. In many cases these

**Interfacing Aids.** Several aids exist to help you get RS-232 interfaces working. The most common is a "breakout box," which is a small board or box with two DB-25 connectors and several switched or wire-jumper interconnect areas in between. The interconnect area allows fast changes to be made between the data lines and among the handshaking lines. Once the right combination has been found, a cable can be prepared with that configuration, or the breakout box can be left in place.

**Conclusion.** We have only really scratched the surface of the Centronics parallel and RS-232 serial interfaces. The information presented here should be enough to clear up most of the fog surrounding interfacing. Hopefully, you can now approach your next interconnecting task with confidence. ◇



# RCA Convertible VCR

*The complete VJP900 system consists of a tuner/timer/charger and a lightweight, fully portable removable VCR*



WITH the most advanced features of a deluxe table model VCR, this new RCA VCR can also be used as a lightweight, fully portable video recorder. Just pull the VCR portions out of its base unit, snap a carrying strap on, or use the optional carrying case, connect a video camera, and you can go out and record. When you've done your recording—up to one hour on a fully charged battery—return the VCR portion to the tuner/timer/charger base and you have a full-feature, high-performance, video cassette recorder. Up to 133 TV channels (broadcast and cable) can be selected by either direct channel access or in the scanning mode, by feather-touch push-buttons on the tuner or by the IR wireless remote control unit. Programs can be selected in a variety of ways up to three weeks in advance, daily or weekly, and up to eight different recording sessions can be programmed. Separate displays show time of day, TV, and a recording timer/counter.

The RCA VJP900 includes five recording heads, five separate microprocessors, and such an array of controls, indicators and connectors that our first impression was one of "everything

*By Walter Buchsbaum*

you've ever wanted in a VCR." Its 43-page operating instruction manual is dwarfed by a  $\frac{3}{4}$ "-thick service manual, but after a little study we found the technical details clearly presented and quite understandable. The operating instructions may be confusing for the first-time VCR owner, but anyone familiar with video recording will thrill to all the possibilities this deluxe equipment offers.

**General Description.** The complete VJP900 system consists of the tuner/timer/charger (VJP900T) and the VCR deck. The combined system weighs 18 lb and measures about  $4\frac{1}{2}$ "H  $\times$  17" W  $\times$  11 $\frac{1}{2}$ " D. The VCR deck itself weighs about 8 lb including the battery, and is about  $3\frac{1}{4}$ "H  $\times$  10" W  $\times$  10 $\frac{1}{4}$ " D. To mount the VCR on the tuner/timer/charger, set it into the two grooves in the base and slide toward the rear until the guide rods engage and the 24-pin and coax connectors mate properly. All dimensions and weights are considerably less than those for RCA's previous VGP170/TGP1500 system but the number of features and detailed

performance characteristics have been greatly increased in the new system.

The TV tuner portion is controlled by three microprocessors that handle the programmed timing (3 weeks, 8 programs, daily and weekly), the tuning voltages for the vhf and uhf tuner itself and the decoding and processing of signals from the IR remote control unit. The block diagram shows the five microprocessors and their interconnection. TV channels can be selected by ten direct dialing numbers or up/down scanning. As long as either up or down button is pressed, each channel will appear just long enough to show what is on. It is also possible to program the scanning system so that only desired channels are tuned in. The NORMAL/CATV switch is used to select cable channels and to accommodate different systems of channel frequency positioning. A switch labelled STD/ICC/HRC is set to the system used by the local cable TV company. Of course, cable channels can also be programmed into the memory.

A hinged subpanel extending over the bottom of the base contains the clock/timer controls. There are 19 pushbuttons for setting the clock and



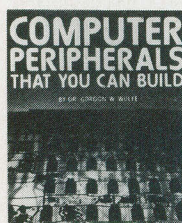
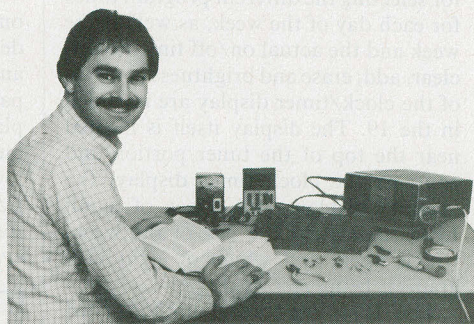


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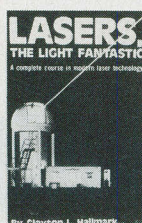
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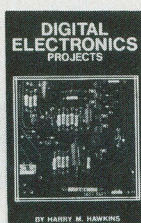
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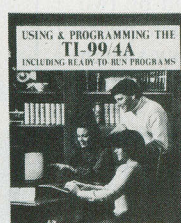
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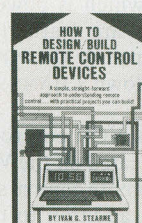
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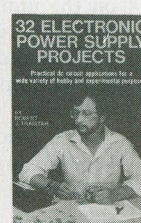
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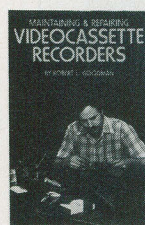
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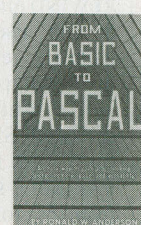
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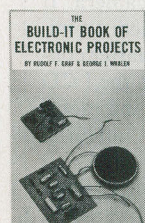
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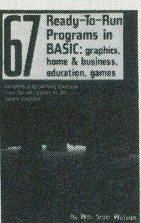
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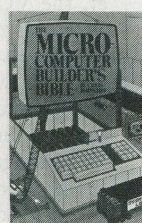
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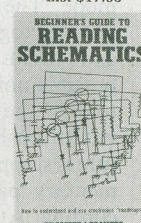
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for selecting the different program times for each day of the week, as well as the week and the actual on/off time. Reset, clear, add, erase and brightness controls of the clock/timer display are included in the 19. The display itself is located near the top of the tuner portion and contains the clock/timer display, the channel display, and a set of small LEDs indicating the day of the week, which week, and which of eight programs is being recorded.

The IR remote control unit looks just like those supplied for RCA's latest color TV sets, but most of its functions deal with the VCR operation. All controls on the unit, which is powered by two AA batteries, are feathertouch push-buttons and include the POWER switch and the up/down CHANNEL scanning controls.

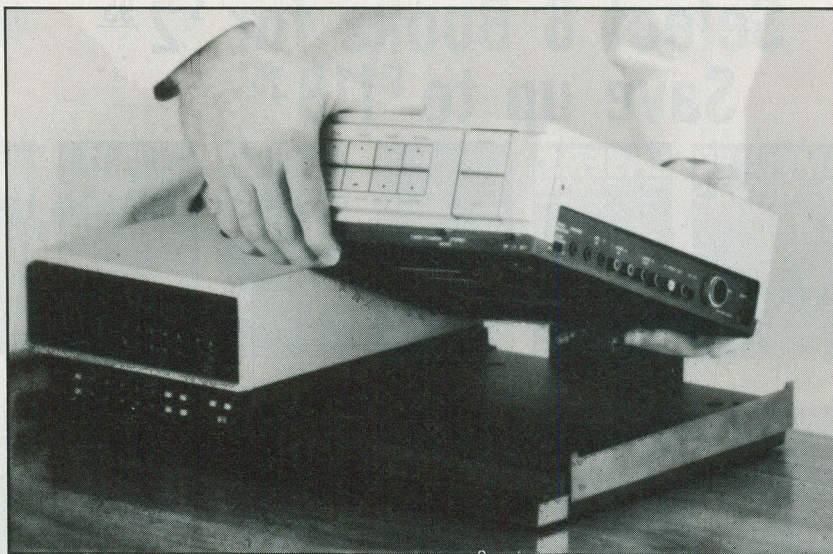
The various VCR controls described here are duplicated on the VCR deck itself, but the remote control signals override them. In addition to the essential controls, such as PLAY, STOP, RECORD, REWIND and FAST FORWARD, the viewer can also control "special effects" from the remote control unit. SEARCH, up/down, permits scanning a recording at five or fifteen times the normal speed (SP and SLP mode). SLOW, pressed first, and followed by the up/down VARIABLE SLOW controls, varies speed from  $\frac{1}{5}$  to  $\frac{1}{30}$  of normal in the SLP mode and from  $\frac{1}{10}$  to  $\frac{1}{30}$  in the SP mode. The SLOW TRACKING controls are used together with the STILL/PAUSE and FRAME ADVANCE controls to move possible noise bands to the top or bottom of the picture. When the STILL/PAUSE pushbutton is pressed, the picture is stopped during playback or a momentary pause is inserted during recording. At the same time, the FRAME ADVANCE control can be pressed to display one frame at a time or held down to advance frames at  $\frac{1}{20}$  of normal speed.

In addition to the controls duplicated on the remote control unit, the VCR deck contains the EJECT, VIDEO DUB and AUDIO DUB switches on the front panel. The dubbing switches permit replacing previously recorded material but cause erasure of that material. Below the front panel are the adjustable tracking control, the audio input selector and the speed switch which selects SP, LP, or SLP. The VCR also has an

connected, all other input signals are automatically disconnected.

The back of the VCR deck plugs into the 26-pin connector of the tuner/timer/charger base and the coax r-f output connector. When the deck is used as a portable VCR, the coax output can be connected directly to any TV set.

The internal operation of the system is based, as mentioned before, on five microprocessors, three of which are lo-



LCD display which shows relative position of programs on the tape or recording time, depending on the setting of the three pushbuttons (RESET, MEMORY, COUNT) just below the display.

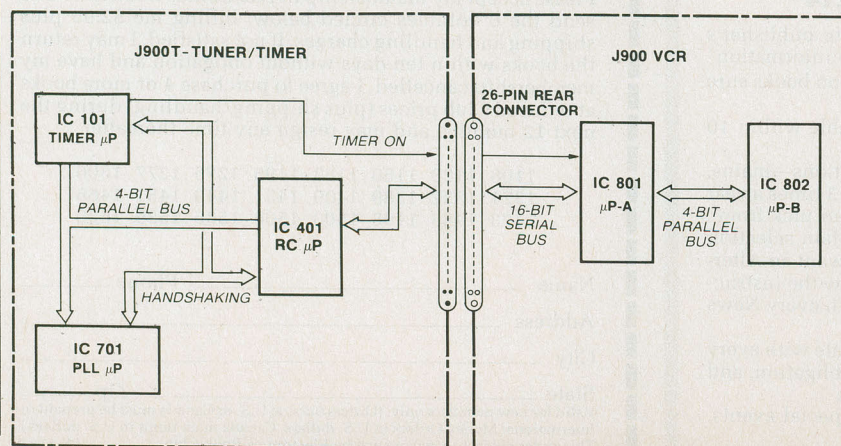
At the side of the VCR deck is the audio noise reduction switch which also selects recording on both or only one sound channel. Another switch selects TV channel 3 or 4 as the r-f output to the TV set. A total of eight RCA phono plugs are used for the various audio and video input and outputs. A 12-volt dc input for automobile or boat power source is accepted by a miniature jack. When the special camera input plug is

cated in the tuner/timer and two in the VCR. Microprocessor A (IC801) accepts control signals from the tuner timer, the VCR and the video camera. It processes them and passes them to microprocessor B (IC802). The latter controls the two motors, operates the LCD display and other indicators, and monitors battery condition and potential trouble signals.

The tuner circuits are essentially identical to those used in RCA's latest TV receiver tuner and i-f sections. A SAW filter precedes the i-f amplifier. Two stages of video amplifiers, together with an elaborate filter (including a crystal 4.5-MHz rejection filter), provide an output with a 4.2-MHz bandwidth.

The fifth recording head that RCA has added in this otherwise conventional VHS recording system has the same azimuth as the SLP channel 2 head but is mounted one horizontal line away from the SLP channel 1 head. In the "still" or "slow" mode, this fifth head, together with the SLP channel 2 head, provide a wide FM output. Channels 1 and 2 operate on the same TV field to prevent any fluctuation. During "still" or "slow" mode, the tape mechanism stops so that the channel 2 SLP head and the fifth head play back the same video track. By using two heads, approximately 180° apart but at the same

Block diagram of the microprocessor communications bus.





azimuth, two identical fields per frame are played back.

The audio section of the VCR provides full stereo recording with separate stereo input and output jacks plus a stereo input phone jack. Two audio amplifier ICs and two analog switching ICs are used on a separate pc board which also contains the noise reduction and the audio dubbing circuits. Audio bandwidth is limited, as in all VCRs, to about 8 kHz for the fastest and 5 kHz for the slowest tape speed.

**Laboratory Measurements.** The tuner test results, as shown in the table, indicate that both the vhf and uhf portions performed extremely well. Their sensitivity and noise figure are essentially the same as those measured on the RCA VGM 2321 color TV receiver/monitor and the Sony component system tuner. The RCA tuner contains separate r-f amplifier stages for vhf, uhf, and the CATV channels and this results in excellent fringe area reception. Using a SAW-filter i-f system, followed by a good video bandpass amplifier, provides 4.2 MHz of video bandwidth. Almost all microprocessor-controlled tuners have the same excellent oscillator stability because they are based on a crystal controlled PLL (phase locked loop).

We checked the operation of the various timing features and the remote control unit and found everything working as indicated in the manufacturer's literature. While there are minor differences, the RCA 3-week, 8-program timing system is essentially the same as that found in most of today's deluxe VCRs.

The technical performance of the VCR itself was very good, but, except for the special effects assisted by the fifth head, not very different from that obtainable from any good VCR. As indicated in the table, the VCR video bandwidth was 2.8 MHz; the resolution, 220 lines; and the signal-to-noise ratio, 45 dB. When we recorded a grey scale and a color bar test signal, we observed no distortion and very good color reproduction. We recorded at all three speeds with no apparent degradation at the slower speeds.

Special effects, still pictures and one-frame-at-a-time especially, clearly show the advantage of the fifth playback head. When we recorded a color bar test signal or an off-the-air TV signal there were practically none of the usual noise bands during slow or still picture playback. When we recorded a signal from a ¾" tape, studio-type VCR we observed a small noise band on "still" pictures. We could move this interference to the top or bottom of the picture with the up/down slow tracking controls.

**User Comment.** As part of our tests we removed the VCR deck from its base and used it as a portable with a video camera. Again, everything worked very well. Of course, picture quality depends greatly on the camera and its correct use, but our results were excellent. Hanging on a shoulder strap the VCR was easy to operate, light to carry and convenient to connect with the camera. The one complaint was that the various indicator lights on the control push-buttons and especially the LCD counter/timer display, were often difficult to see in sunlight. Greater familiarity with this VCR will reduce the need to check the status of these indicators, but for the first-time user it was definitely a problem.

After considering all the great features and wonderful performance of this RCA Tuner/Timer/Charger VCR, we thought of the new standards for ¼" video tape recording and couldn't help wondering just how compact and light the ¼" version of this VCR will be in a few years from now. For the present, however, we can see that the combination represented by the RCA VJP900 has a great many assets.

Other manufacturers offer portable VCRs, but, as far as we know, RCA is the first to come out with a system that combines a full-featured, deluxe VCR that can also be used as a portable. This arrangement appears ideal for the person who is seriously interested in a total

video system, including a video camera, a portable VCR, a tuner and timer and a high-quality video monitor. If we consider any of the component TV systems, the cost of a tuner/timer plus a VCR is about the same as the RCA tuner/timer/charger and VCR combination. If we add the portability feature of RCA's VCR, \$1300 may be a bargain.

The JVC model HR-C3U, reviewed in our January 1983 issue, was priced at \$850 and did not include a tuner or timer. It weighed only 5.3 lb (compared to RCA's 8 lb and was a little smaller but it required a special cassette that could record for only 20 minutes. To play the JVC portable cassette back on a standard VCR, a special adapter was necessary.

For the person who is primarily interested in recording TV programs, the RCA tuner's 133-channel capacity seems attractive. High performance tuner/timers such as the Sony, NEC and others are also capable of receiving CATV and for these component TV systems a lower cost VCR, without tuner and timer, may be satisfactory. Again, the portability of the VCR deck is the key factor in such a situation.

Finally, when we fed the tuner video output signal to our studio-type monitor, our group of studio technicians agreed that the TV pictures were just as excellent as those previously admired in each of the top component TV systems. Obviously, this tuner is great.

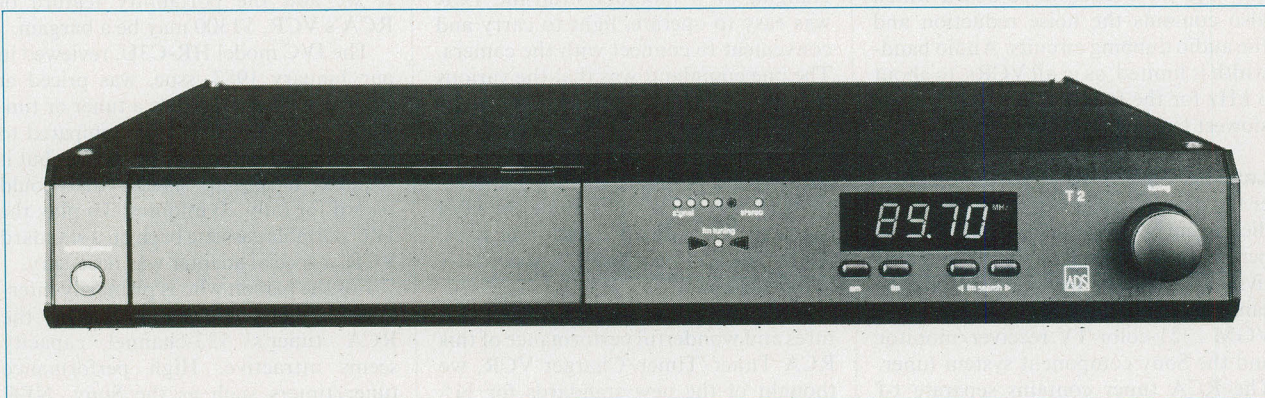
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## RCA VJP900 VIDEO CASSETTE RECORDER LABORATORY MEASUREMENTS

Parameter	Measurement
<b>Tuner/Timer</b>	
Sensitivity, vhf (Ch. 3):	58 dBm
Sensitivity, uhf (Ch. 20):	56 dBm
Noise figure, vhf (Ch. 3)	5 dB
Noise figure, uhf (Ch. 20)	8 dB
Video bandwidth to video input (-6 dB):	4.20 MHz
Oscillator stability (Ch. 3):	0.05 MHz
(105 to 130 V ac, 2 hr) (Ch. 20):	0.05 MHz
Osc. Freq. Error (Ch. 3):	0.05 MHz
Agc dynamic range:	68 dB
A-f response	100 to 8000 Hz
Voltage regulation (105 to 130 V ac):	98%
Power:	55 W (incl. VCR & camera)
<b>VCR</b>	
Video bandwidth (-6 dB):	2.8 MHz
Resolution:	230 lines
Video input:	1 V, p-p
Video S/N:	45 dB
Grey scale:	Excellent
Color fidelity:	Excellent
Interference distortion:	None
Power (12 V):	7.3 W



# ADS "Atelier" T2 AM/FM Tuner



**M**ODULAR design of audio components has been advanced tremendously by the recent introduction by Analog & Digital Systems Inc. (ADS) of its "Atelier" line of units—actually made by its West German affiliate, Braun Electronics Laboratories.

These distinctively styled components have the same key dimensions and basic enclosure design so that they can be stacked one on top of the other in almost any order. An optional matching pedestal can then be obtained to make an attractive free-standing unit, or the components can be placed more conventionally on a shelf or table.

Currently, the ADS Atelier series consists of a receiver, cassette deck, turntable, integrated amplifier, and the new T2 AM/FM tuner, which was tested for this report. The ADS T2, like its companion pieces, is finished in black, with bevelled upper and lower front panel edges. It measures about 17½" W × 14⅞" D × 2¾" H, and weighs 13.2 lb. Most of the controls are out of sight behind a hinged door at the left of the panel.

The tuner's most visible features are a digital frequency display window (with large ½"-high yellow-green numerals) and the tuning knob to its right. Four small buttons below the window select AM or FM reception, and initiate an automatic search scan mode (FM only). Momentarily pressing one of the FM search buttons starts the tuner scanning rapidly in the selected direction. It stops and unmutes when it encounters a signal exceeding the muting threshold. Green LEDs to the left of the window light in sequence to indicate relative signal strength, and another shows the presence of a stereo pilot carrier on an

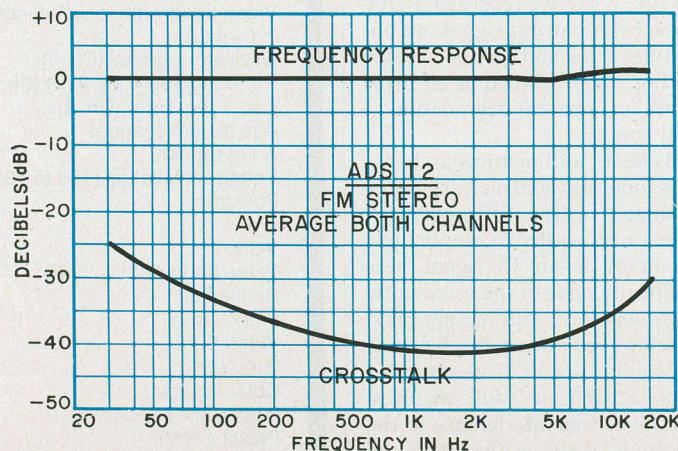
FM signal. Below them is a single green LED that lights only when an FM station is tuned correctly. It is flanked by red arrows that light when the tuner is close to the station frequency to show the correct tuning direction.

The ADS T2 is digitally synthesized, tuning in 100-kHz steps for FM and 10-kHz steps for AM. The large tuning knob rotates freely, with a definite fly-wheel action, but with a large number of lightly detented positions, each corresponding to one tuning interval. At the extreme left of the panel is a green "system power" switch button. This controls not only the tuner, but 3 of the 4 ac outlets in the rear, allowing the T2 to serve as a system control center as well as a tuner.

On the left is a hinged door behind which are 4 round buttons, 9 small rectangular buttons, and a small knob. Eight of the small buttons are station memory selectors, and the ninth is used

when storing a channel frequency in one of the memories. Although there are only 8 buttons, the T2 can store up to 16 preset frequencies, the buttons being switched between the 1-8 and 9-16 banks by one of the round buttons above them. Each can be used for either an FM or an AM channel (but not both). Operating one of the buttons automatically selects the correct band as well as the channel frequency. The memories are kept "alive" so long as the tuner is plugged into an energized outlet. A green LED in the frequency display window lights when the power switch is turned off as a reminder that the memory power is still on. Even with no power connection, the memories are retained for several days. (We verified that they lasted more than a week.)

The other round buttons behind the door switch the tuner to mono, blend the high frequencies for noise reduction on weak stereo signals, and switch the



Frequency response and noise for both channels.



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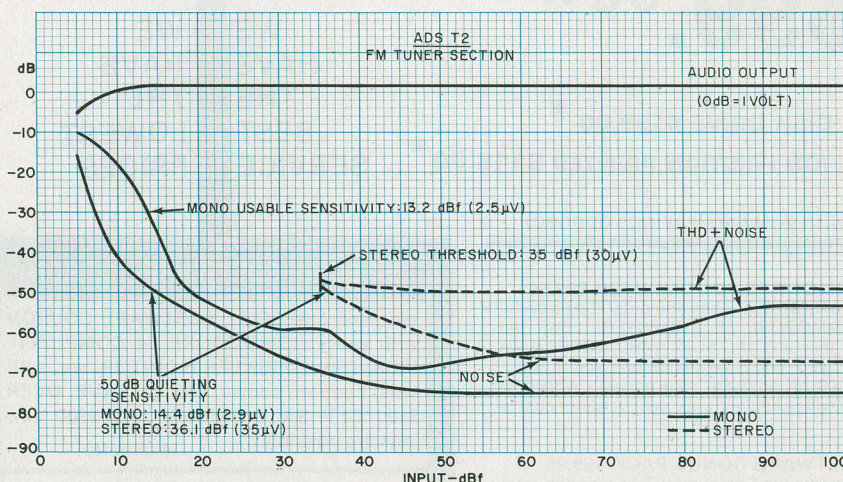
muting on or off. The small knob, marked "fine tuning," gives the T2 a capability unique among the synthesized tuners we have seen. Normally, such a tuner can be set only to discrete frequencies, determined by its internal quartz-crystal reference oscillator. If the reference is accurate, the received stations are on their exact assigned frequencies, and the tuner's i-f and detector circuits are aligned correctly, this system assures exactly correct tuning. If any one of those conditions is not satisfied, one may not be able to realize the low noise and distortion, and interference rejection, of which the tuner may be capable. Usually there is nothing the user can do to compensate for the incorrect condition.

However, the ADS T2 "fine tuning" knob gives it a continuous vernier tuning range of at least  $\pm 25$  kHz on the FM band (center-detuned for normal operation). This can be useful when receiving FM signals through a cable distribution system, in which the center frequency accuracy is not necessarily as good as required by the FCC for the FM broadcasters themselves. It may also be advantageous in cases of adjacent-channel interference, where the tuner's i-f selectivity can be used to aid rejection of an unwanted signal without materially degrading the sound of the desired signal.

On the rear apron of the T2 are binding posts for an AM long-wire antenna (there is no built-in ferrite antenna) and a 300-ohm FM antenna feeder, plus a coaxial "F" type connector for a 75-ohm FM antenna system. The T2 contains a balun transformer to match either antenna impedance. The audio outputs are through phono jacks, at a fixed level. There are 4 ac outlets, 3 of them switched. A matching metal strip can be inserted to enclose the rear of the tuner after all cables have been connected, preserving an attractive appearance from any viewpoint. (The other Atelier units have a similar feature.)

The price of the ADS T2 is \$399.

**Laboratory Measurements.** Almost every performance parameter of the ADS T2 that we were able to measure matched or surpassed its ratings, with due allowance for normal measurement uncertainties at FM frequencies. All FM measurements were made through the 300-ohm antenna input. The mono usable sensitivity was 13.2 dBf (2.5  $\mu$ V), and the stereo sensitivity was set by its switching threshold of 35 dBf (30  $\mu$ V). The more meaningful 50-dB quieting sensitivity in mono was 14.4 dBf



Audio output, sensitivity, and noise for tuner section.

(2.9  $\mu$ V) and in stereo it was 36.1 dBf (35  $\mu$ V).

The mono distortion at 65 dBf (1000  $\mu$ V) input was only 0.06% (approximately the residual level in our Sound Technology 1000A signal generator). Only our stereo distortion measurement failed to match the tuner's ratings. (We measured 0.32%; the rating is 0.15%.) This measurement is critically dependent on the specific characteristics of the signal generator and alignment of the tuner circuits, so the apparent discrepancy is actually of little significance and would doubtless not exist with another generator (or using our generator with a different tuner).

The tuner noise level was a good -75 dB in mono and -67 dB in stereo. Other FM performance characteristics included a capture ratio of 2.36 dB at 65 dBf, AM rejection of 55 dB at 45 dBf (100  $\mu$ V), and excellent image rejection of 91 dB. The selectivity of the T2 was also well above average—84 dB for alternate-channel (400-kHz) spacing and 11.4 dB for adjacent-channel (200-kHz) spacing. The muting threshold was 19.2 to 23.3 dBf (5 to 8  $\mu$ V), and the stereo switching threshold was 31.2 to 34.7 dBf (20 to 30  $\mu$ V). The range of values represents an intentional switching hysteresis so that signals around the threshold level do not constantly drop in and out or fluctuate between stereo and mono modes. The 19-kHz pilot carrier in the audio was suppressed to a low -70 dB, and the power line hum was also low at -72 dB.

The FM frequency response was flat within  $\pm 0.5$  dB from 30 to 15,000 Hz. The channel separation was about 41 dB in the midrange (500 to 4000 Hz), reducing to 25 dB at 30 Hz and 30 dB at

15,000 Hz. The AM frequency response rolled off at low and high frequencies, to -6 dB at 130 and 2300 Hz, relative to the 1000-Hz level.

**User Comment.** The ADS T2 is one of the more intelligently designed hi-fi products we have seen. In normal operation, only the essential controls are visible, and there is actually no need to study the instruction manual (a very good one, by the way) in order to use the tuner effectively. On the other hand, the T2 has just about every useful operating and convenience feature one could ask for in a tuner. In all respects, its "human engineering" is outstanding.

Tuning the T2 is pure pleasure. If (like us) you feel more comfortable turning a knob than pushing a button for tuning a receiver, here is a tuner that combines the "friendliness" of an analog tuner with the precision and fool-proof tuning of a digitally synthesized tuner.

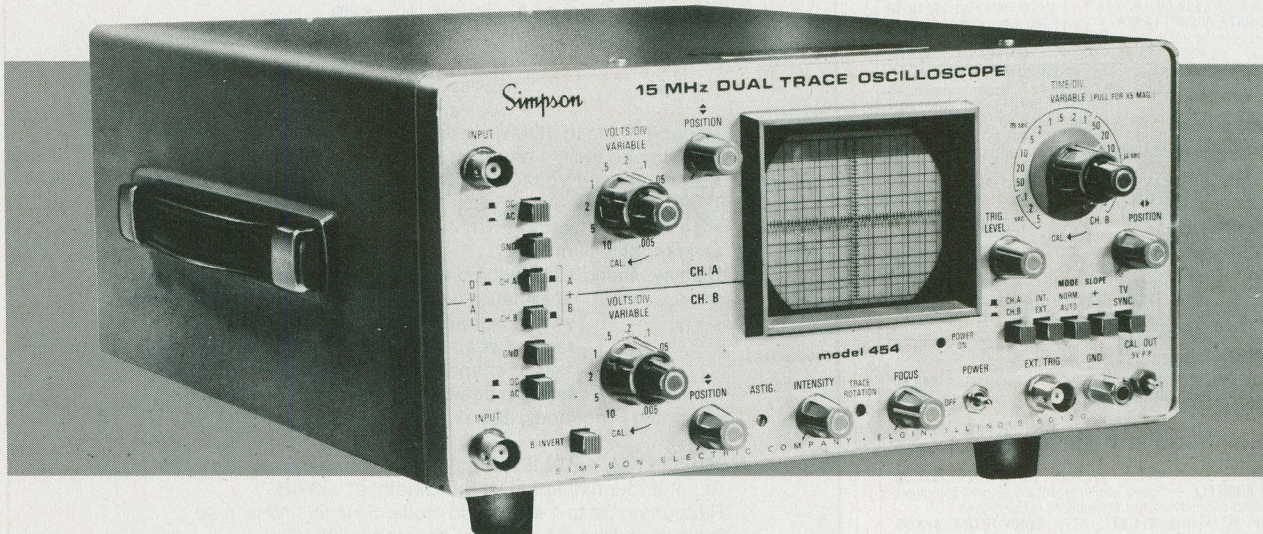
Furthermore, the T2 sounds as good as it looks, which is not very surprising in view of its excellent bench performance. Frankly, we did not find a single "bug" or irritating characteristic during our use of this tuner. The usual "bells and whistles" (but few of their useful functions) have been omitted from this handsome tuner and replaced by tasteful styling and ease of operation. Incidentally, the T2 feels heavier than it would appear, and this is partly due to its heavy steel top plate, designed to support the weight of one or more other Atelier components stacked in it. The tuner has a very solid look and "feel" that is much more than an illusion.

—Julian D. Hirsch

Circle No. 93 on Free Information Card



## Simpson Model 454 Dual Trace Oscilloscope



The Simpson 454 Dual Trace Oscilloscope is designed for general-purpose observation of one or two waveforms. The 200-kHz chopping mode is intended for low-frequency signals, and the sweep is automatically switched to the alternate mode in the presence of high-frequency waveforms. The scope's basic features are: dual trace, dc-to-15-MHz vertical amplifier response, 5-mV/div. vertical and horizontal sensitivity, and a sweep rate of 100 ns/div. vertical and horizontal sensitivity, and a sweep rate of 100 ns/div. to 0.5 s/div. Thus it is ideal for lab measurements, industrial maintenance, and general electronic troubleshooting.

The instrument measures 4 $\frac{5}{8}$ " H  $\times$  9 $\frac{7}{8}$ " W  $\times$  13 $\frac{1}{4}$ " D and weighs about 13 lb. The suggested retail price is \$730.

**General Description.** Simpson's design engineers have used IC technology and a 3" CRT to create an instrument whose compact size makes it welcome even on a crowded workbench. Four rubber feet (along with a tilt stand) are provided on the bottom for bench use. An additional four rubber feet, located on the side opposite to the built-in carrying handle, enable the 454 to be placed on the ground without soiling the case.

All controls and connectors are logically grouped with the two signal inputs on the left side, the sweep controls and triggering on the right side, and the CRT controls under the CRT bezel. The front panel is brushed silver with color-coded contrasting control knobs.

The rear apron carries the line cord supports and the fuse.

Each vertical input has four associated controls: the AC/DC push-button selector; an 11 position VOLTS/DIV selector switch arranged in a 1-2-5 sequence; a VARIABLE vernier; and a POSITION control. Signals arrive via a BNC connector.

Horizontal swept time can be selected by a 19-position TIME/DIV switch with selection between 0.5 seconds/div and 0.5  $\mu$ s/div. The coaxial sweep VARIABLE control can be pulled out for  $\times 5$  magnification. Both TRIG LEVEL and horizontal POSITION controls are provided. Pushbuttons enable selection of trigger sources for CH A, CH B, INT/EXT, NORMAL/AUTO, SLOPE, and TV SYNC. An external trigger BNC connector and a CAL OUT 0.5-V peak-to-peak test signal are also provided.

The INTENSITY and FOCUS controls are positioned below the CRT bezel along with the POWER switch and indicator, and screwdriver-adjust ASTIG and TRACE ROTATION adjustments. The

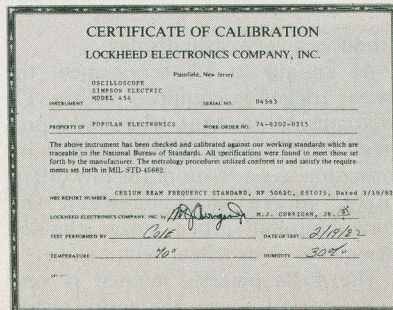
last switch, B INVERT, can be used to flip over the CH B signal.

The 3" round, flat-faced CRT is surrounded with a 3"  $\times$  2 $\frac{1}{2}$ " bezel that carries the graticule plate. Complete specifications are shown in the accompanying Table.

**User Comments.** The Simpson 454 was tested by the Lockheed Electronics Instrumentation Measurement Laboratories (Plainfield, NJ) against standards traceable to the National Bureau of Standards, and the instrument was found to meet or exceed its claimed specifications.

As usual, we put the 454 to work on our test bench and awaited comments by the users. They all agreed that this was a good-quality scope having excellent readability, even at high CRT writing speeds, and exceptionally stable sync. Taking advantage of its relatively small size, light weight, and convenient carrying handle, the 454 was used on several outside service calls. Its performance was excellent away from the bench.

At first we were concerned that the small CRT display could cause eyestrain from squinting at tiny waveforms. However, the expected "uncomfortableness" never materialized, mostly due to the 454's clean, bright, traces. There is plenty of room around each control knob. Functions are easy to use, and fingers never obscure the CRT. After several weeks of use, no one made any unusual comments about the small CRT—other than to point out that it







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(Channels A and B) Bandwidth, at —3 dB.

Deflection Sensitivity: 5 mV/div to 10 V/div in a 1-2-5 sequence, 11 steps. Accuracy is within  $\pm 5\%$  of full-screen deflection. Uncalibrated continuous variable control between steps.

Response: Dc to 15 MHz in dc mode, 5 Hz to 15 MHz in ac.

Input Impedance: 1 megohm shunted by 25 pF.

Maximum Input Voltage: 500 V (dc + ac peak) with X10 probe.  
250 V with X1 probe to 1 kHz.

Rise Time: 24 ns.

Overshoot: 5% or less.

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### HORIZONTAL AMPLIFIER

(Input through channel B) Bandwidth, at —3 dB.

Response: Dc to 1 MHz in dc mode, 5 Hz to 1 MHz in ac.

Input impedance: 1 megohm shunted by 25 pF.

Maximum Input Voltage: 500 V (dc + ac peak) with X10 probe.  
250 V with X1 probe.

Deflection Sensitivity: 5 mV/div to 10 V/div calibrated in 1-2-5 sequence, 11 steps, accuracy within  $\pm 5\%$  full screen deflection, uncalibrated continuous variable control between steps.

Calibration Voltage: 0.5 V peak-to-peak  $\pm 1\%$ , 1 kHz square wave

### HORIZONTAL SWEEP RANGES

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Magnifier: X5 (Expands fastest sweep to 0.1  $\mu$ s/div.)

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Source: External, channel A or channel B.

Mode: normal and automatic.

Coupling: Ac.

Slope: Positive or negative.

Trigger Sources and Sensitivity:

Normal and Auto:

Internal: 1 div from 5 Hz to 15 MHz.

0.5 div from 10 Hz to 10 MHz.

External: 0.5 V peak-to-peak from 5 Hz to 15 MHz.

Auto: 1 div peak-to-peak of deflection from 50 Hz to 15 MHz.

TV Sync: 0.5 div.

Max. External Input: 100 V peak-to-peak (ac + dc)

Ext. Trigger Input impedance: 100,000 ohms in parallel with 35 pF.

produces a very clean display.

As an aid to TV servicemen, the sweep trigger is equipped with a TV SYNC pushbutton that, when used, provides a rock-steady display of video information. As a result of the low differential phase shift between the horizontal and vertical stages, the 454 also makes an excellent vector scope.

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tion of the scope. It includes a lengthy section on applications and how to use the instrument to best advantage.

The Simpson 454 Dual Trace Oscilloscope is an excellent choice for the modern service bench and deserves careful consideration if you want a good bench scope that also offers portability where there's access to an outlet.

—Les Solomon

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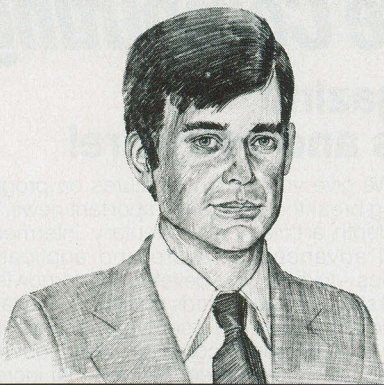
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# THE ELECTRONICS SCIENTIST



## Optical Data Communications An Experimental Infrared Joystick Interface A New Class of Semiconductors

By Forrest M. Mims, III

IF YOU own a fairly sophisticated personal computer system, i.e. computer, disk drives, printer, modem, joysticks, etc., you're well acquainted with the jumble of wires and cables that it creates. In this month's column, we'll examine one possible solution to this problem: optical data links employing near-infrared-emitting diodes.

While preparing the material on infrared data links, I decided to tackle a particular nuisance called the joystick cable. The result of my efforts is an experimental free-space, near-infrared, joystick-computer link designed specifically for use with Radio Shack's Color Computer.

This month we'll also experiment with a very simple model railroad crossing light. And we'll look at several new devices including some new power MOSFETs and a voltage sensing IC you should know about.

## Optical Data Communications

When Atari introduced its wireless, remote-control joystick system, my first reaction was that someone had finally replaced the clumsy joystick cable with an infrared-emitting diode. Subsequently, though, I discovered that the Atari system uses miniature radio transmitters. A stubby antenna protrudes from

each joystick assembly, and a longer, telescoping antenna extends from the receiver unit that connects to the computer.

Since I've spent many hours using joysticks and other graphic input devices for genuinely useful applications (no, I'm not a video game freak), I'm delighted that Atari has seen the wisdom of replacing those bothersome joystick cables with a wireless link. But I'm puzzled as to why they and many other companies haven't yet introduced free-space infrared data links for computers and their peripherals.

While many companies make fiber-optic data-transmission links, most electronic equipment manufacturers have been very slow to adopt near-infrared-emitting diodes for transmission of data through free space. This is all the more puzzling when one considers that there are some similarities in both the components and the operation of fiber-optic and free-space near-infrared data links.

Since both infrared-emitting and detecting diodes and a host of modulation and demodulation methods were pioneered in the United States, we certainly cannot plead ignorance of the subject. Perhaps our love affair with radio is the culprit.

In any event, though audio was first transmitted over light in the United States (beginning with Alexander Graham Bell in 1880), infrared-coupled high-fidelity earphones and speakers were first manufactured on a commercial scale in West Germany. Similarly, while we and the Japanese were building radio-controlled toy cars, a German company introduced an infrared-controlled toy vehicle with detection circuitry so sensitive it responds to signals bounced from ceilings, walls, people and plants. Unlike its radio-controlled counterparts, it completely ignores

transmission from CB operators and passing taxis. And it is subject to no rules regarding frequency, radiated power, and antenna size.

As for computers, several companies have finally begun to recognize the advantages of short-range, free-space, infrared data links between computers and peripherals. In 1979, for instance, Fritz R. Geller and Urs Bapst of IBM's Zurich Research Laboratory in Ruschlikon, Switzerland, published a paper describing in detail the transmission of in-house data by means of reflected beams of near-infrared ("Wireless In-House Data Communication via Diffuse Infrared Radiation," *Proceedings of the IEEE*, Nov., 1979).

This excellent paper discussed virtually all aspects of practical in-house infrared data transmission. Block diagrams of typical systems, design equations and detailed discussions concerning the near-infrared reflectance properties of various surfaces were included.

Never slow to adapt a useful technology, several Japanese computer firms have recently developed or introduced various kinds of near-infrared coupled, in-house, wireless, data-transmission systems. One of the most ambitious is an infrared modem developed by Fujitsu, a major Japanese manufacturer of computers.

Designed specifically for office automation, Fujitsu's system optically links several terminals equipped with infrared transceivers to one of several satellite transceivers connected by conventional cable to a central processor. The system is RS-232 compatible at full or half duplex with data rates of up to 19.2 kilobaud. The normal operating range of the system is about ten meters, but this is reduced to about three meters should any of the system's photodiodes be exposed to direct sunlight.

Incidentally, Fujitsu's system uses

$$R = \sqrt{\frac{4 P_0 A_{rec} \tau}{\pi P_{th} \theta^2}}$$

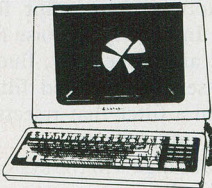
$\tau$  = TRANSMISSION OF RECEIVER OPTICS (IF USED)  
 $P_{th}$  = RECEIVER SENSITIVITY (WATTS)

Fig. 1. Range equation for line-of-sight operation.



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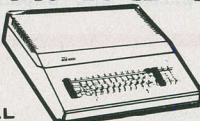
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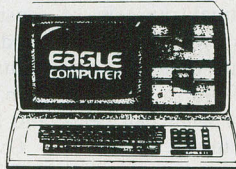
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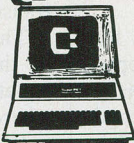
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## ...ELECTRONICS SCIENTIST

the new high-power AlGaAs "super" LEDs I've described several times in this magazine. Each terminal transceiver uses five diodes, each of which emits about 15 mW. The satellite stations use nine diodes.

Fujitsu's system shows what can be done on a large scale with infrared links. But I think you'll be more interested in a new handheld computer developed by Canon that can communicate with a printer by means of a midget infrared data link that plugs into the computer's RS-232 port. According to *Electronic Engineering Times*, Canon may formally introduce this new computer later this year.

**Design Tips.** Possibly one reason for the slow development of free-space optical data links for computers and nearby terminals and peripherals is the special design requirements imposed by such a system. First, a communications format must be selected. For instance, will one LED channel be sufficient or will others be required? What form of multiplexing, if any, will be used?

Next, a suitable LED and LED driver must be selected. If high data rates are not a requirement, high power AlGaAs near-infrared emitters are the best choice. A power MOSFET makes an excellent driver for these and other infrared-emitting diodes. For more power, several LEDs can be connected in series.

Many kinds of receivers are possible. A typical design might employ a photodiode or phototransistor detector fol-

lowed by a low-noise, high-gain amplifier. Low noise is important for high sensitivity. Immunity to noise from incandescent and, especially, fluorescent lights is essential. Infrared filters can help. So can a filter that rejects 60-Hz and 120-Hz interference.

Over what range will the system operate? Two simple range equations can be used to give reasonable predictions. Both equations require a knowledge of such parameters as the optical output power from the transmitter ( $P_o$ ), the receiver sensitivity ( $P_{th}$ ), the area of the receiver's detector chip or lens ( $A_{rec}$ ), the divergence or beam spread angle of the transmitter in radians ( $\theta$ ), and the transmissivity of the receiver's optics ( $\tau$ ).

The first equation, a simplified form of the optical communications range equation, is for line-of-sight operation where the infrared emitted by the transmitter's emitter has an unobstructed, direct path to the detector. In this case, the range is the square root of  $(4P_o A_{rec} \tau) / (P_{th} \pi \theta^2)$ . Figure 1 summarizes this equation.

The second equation, a simplified form of the optical radar range equation, is for systems in which the transmitted beam is reflected from diffusely reflecting walls, ceilings, and other surfaces before reaching the receiver's detector. In this case, the range is the square root of  $(P_o A_{rec} \rho \tau) / (P_{th} \pi)$ . This equation is summarized in Fig. 2.

The Greek letter  $\rho$  (rho) denotes the reflectance of the surface from which the transmitted beam is reflected. At 880 nm, plaster and unpainted pine

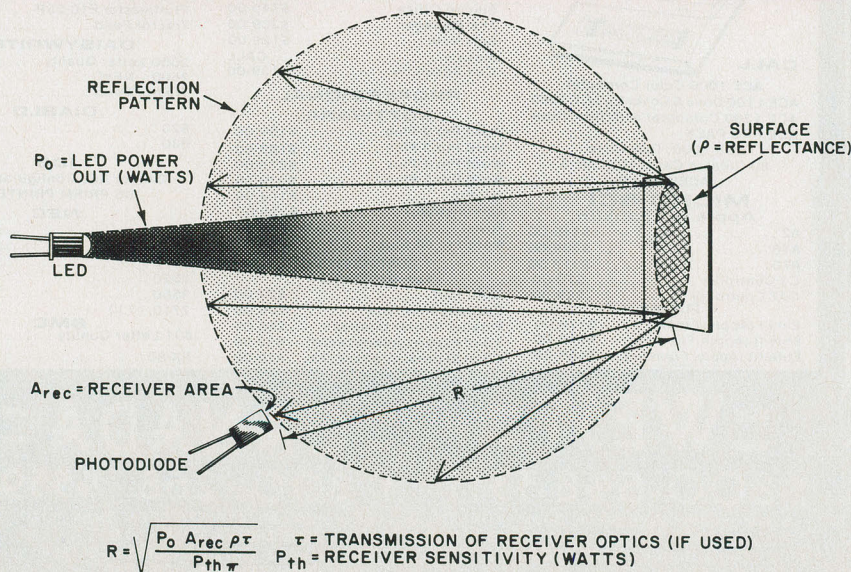


Fig. 2. Range equation for operation with a diffuse reflector.



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have a typical reflectance of about 70% (0.7). Human skin and green vegetation have typical reflectances of 50 to 60% (0.5 to 0.6). (In the near infrared, differences in skin pigmentation are barely discernable.)

## An Experimental Infrared Joystick Interface

Radio Shack's TRS-80 Color Computer can be equipped with two joysticks. Each includes two mechanically linked potentiometers and a "fire" switch. Figure 3 shows the internal circuitry of each joystick.

The *Color Computer Technical Reference Manual* (Radio Shack, 1981) gives complete details about the operation of the Color Computer's joysticks. Briefly, the two potentiometers in each joystick function as voltage dividers. As the wiper of a potentiometer is rotated, the voltage appearing across the wiper and ground varies from ground to +5 V. This voltage is applied via joystick input ports to a 6-bit digital-to-analog converter circuit in the Color Computer. A built-in software routine uses a successive approximation method to find, to the 6-bit accuracy of the D/A converter, the voltage equivalent of the position of the joystick. Since there are either two or four joystick potentiometers, a multiplexer is required to direct the selected potentiometer to the D/A converter.

One way to replace the cable between the joysticks and the Color Computer with an infrared link is to employ a pair of LEDs, each driven by a pulse generator with a repetition rate determined by the resistance of its respective joystick potentiometer. A pair of receivers

would detect and amplify the signals from the LEDs and pass them to respective frequency-to-voltage converters. The resultant output voltages would then be applied to the joystick input ports of the Color Computer (Figure 4).

**A Working Circuit.** To test this idea, I assembled a working version of one of the channels shown in block diagram form in Fig. 4. The transmitter is shown in Fig. 5. The circuit is a straightforward pulse generator designed around a 555 timer whose pulse repetition rate is determined by joystick potentiometer *R1* and timing capacitor *C1*. Pulses from the 555 (pin 3) switch *Q1* on and off, thus applying current to infrared-emitting diode *LED1*. Resistor *R4* limits its current through the diode to less than 100 mA.

Figure 6 shows one of several simple receivers I tested that can detect the signal from the transmitter, amplify it and convert the variable pulse rate into its respective voltage.

For best results, especially in the presence of ambient light, a pin photodiode such as the Texas Instruments TIL413 (Radio Shack 276-144 or similar) should be used. This particular photodiode includes a built-in infrared filter that substantially improves performance in the presence of incandescent

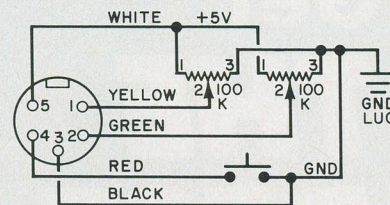


Fig. 3. Internal circuitry on the TRS-80 Color Computer joystick.

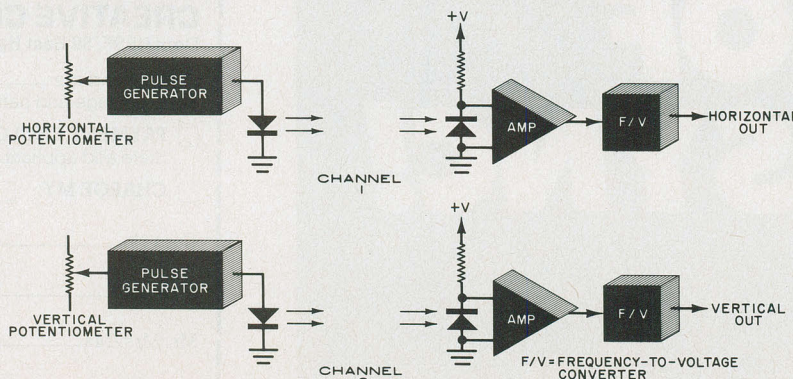


Fig. 4. Block diagram of infrared computer-joystick interface.



and fluorescent indoor lighting. A phototransistor can also be used, but noise immunity may be a problem.

If you use a phototransistor, connect its collector to the junction of *C1* and *R1* and its emitter to ground. You will also need to reduce *R1* to about 100K. Keep in mind that, while the phototransistor has built-in gain, the photodiode is less susceptible to the effect of ambient light.

I used a pair of 741 operational amplifiers to amplify the received signal, but many other amplifier arrangements can also be used. A 60-Hz or 120-Hz notch filter can also be included.

The frequency-to-voltage converter is designed around the familiar 555. Components *R9* and *C5* at the output of the 555 form an integrator that transforms the pulses from the 555 into a variable dc voltage.

While I've had good results with the 555 in this role, you can also use the 9400 or LM311 in their frequency-to-voltage converter roles for superior results. Both these chips were described in an installment of "Experimenter's Corner" in *POPULAR ELECTRONICS* (November 1979; reprinted in *The Forrest Mims Circuit Scrapbook*, McGraw-Hill, 1983).

**Testing the Interface.** I tested the experimental infrared joystick-computer link by disassembling a Color Computer joystick and unsoldering the yellow wire from the wiper terminal of one of the two potentiometers. I then connected this wire and the joystick's black wire (ground) to, respectively, the output of the receiver and its ground.

I then entered the following joystick test program into the Color Computer:

```
10 CLS
20 PRINT @0, JOYSTK (0);
```

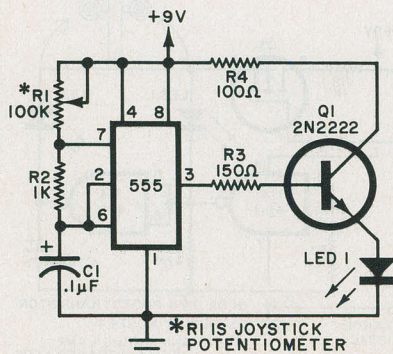
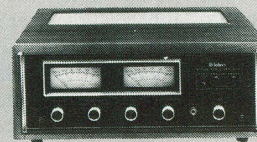
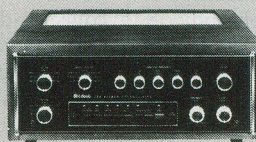
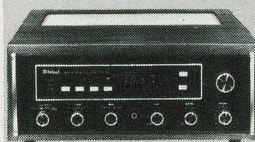
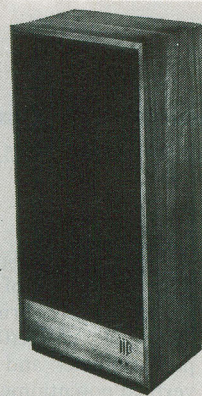


Fig. 5. Single-channel near-infrared joystick transmitter.

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```
30 PRINT @5, JOYSTK (1);
40 GOTO 20
50 END
```

This simple program prints the coordinates (0 to 63) of the right joystick at the upper left corner of the monitor's screen. JOYSTK(0) is the horizontal potentiometer and JOYSTK(1) is the vertical potentiometer.

For initial tests, the transmitter's LED and the receiver's photodiode should be closely spaced and pointed directly at one another. When the system is operating properly, move the transmitter away from the receiver to determine the maximum range. The prototype circuit I built gave a maximum range of about four feet when a photodiode detector was used at the receiver. A phototransistor at the receiver gave a maximum range of about three feet. If the coordinates of JOYSTK (0) do not reach the full range, you may need to alter the value of C1 in the transmitter.

You can monitor the output of the receiver with a high-impedance voltmeter. And you can gain a better understanding of the entire transmitter-receiver system by using an oscilloscope to observe pin 3 of the transmitter's 555 and the outputs of the various stages of the receiver. If you are able to perform these tests, be sure to experiment with the position of the transmitter's LED with respect to the receiver's photodiode.

**Going Further.** The simple infrared joystick-computer interface described above links only one of the potentiometers in the joystick with a Color Computer. One way to link both potentiometers is to assemble two identical transmitters and receivers as suggested in Fig. 4. Use an 880-nm LED for one transmitter and a 950-nm LED for the second transmitter. Replace the receiver photodiodes with identical LEDs. In other words, the 880-nm transmitter should be coupled with a receiver that uses an 880-nm LED as a photodiode. Since the LEDs can function as wavelength selective detectors, the system will provide a wavelength-multiplexed, two-channel link between the joystick and the computer.

The range of the system in which LEDs are used as photodiodes will not be as great as the system in which a silicon pin photodiode is used. Therefore, you may wish to explore various electronic multiplexing methods to send both channels of information from a joystick to a computer.

You can increase the transmission

range of the infrared joystick-computer link by adding additional LEDs in series with LED1 of the transmitter. Also, select LED1's current limiting resistor, R4, to provide the highest possible current consistent with the power ratings of LED1, Q1 and R4. For maximum power, Q1 and LED1 may require heatsinks. A power MOSFET can be directly substituted for Q1. The equivalent connections are base-gate, emitter-source and collector-drain.

If you want to further explore the topic of infrared free-space data links for computers and their peripherals, be sure to read the excellent IEEE paper mentioned earlier in this column. For more details about infrared data links in general and a derivation of the line-of-sight range equation (Fig. 1), see *A Practical*

*Introduction to Lightwave Communications* (Forrest M. Mims, III, Sams, 1982).

## Simplified Model Railroad Crossing Light

In a previous column for this magazine I described an optically triggered model railroad crossing light ("Project of the Month," May 1981). Recently, while writing a new book for Radio Shack called *Getting Started in Electronics*, I found that the original circuit can be considerably simplified, as shown in Fig. 7.

Two 4011 CMOS NAND gates form

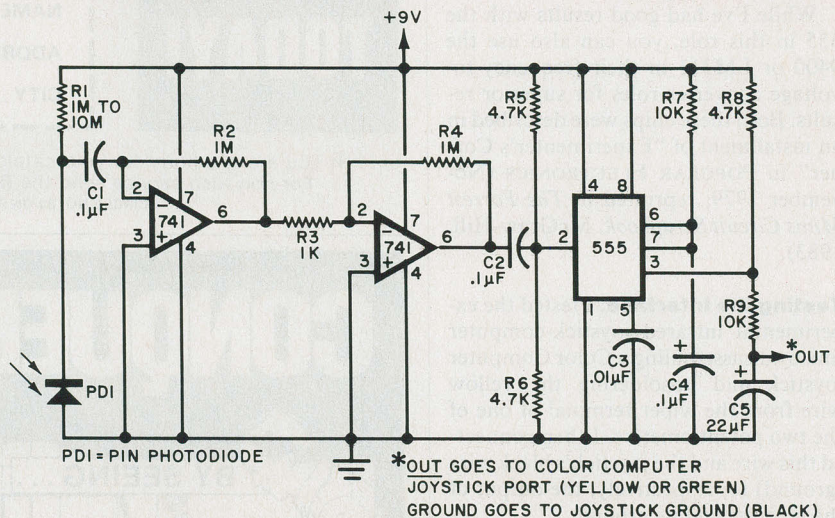


Fig. 6. Single-channel infrared-coupled joystick receiver.

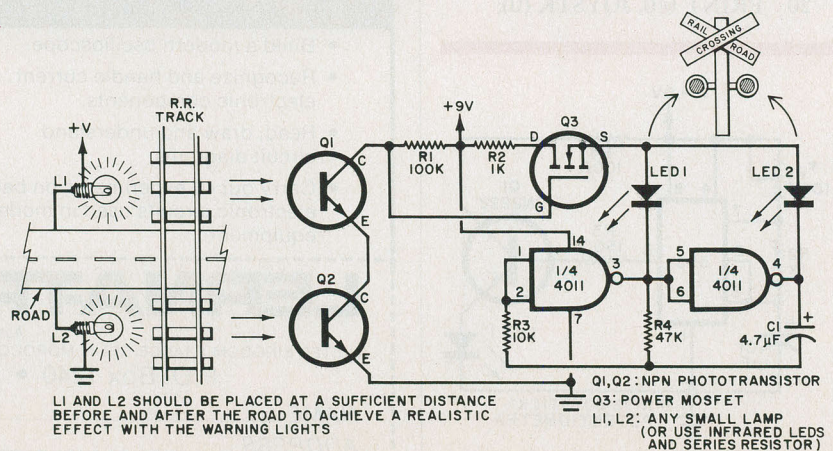


Fig. 7. Simple model railroad crossing light.



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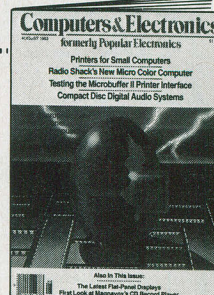
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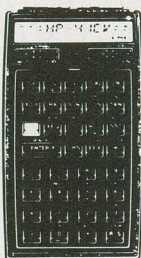
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When both  $Q1$  and  $Q2$  are illuminated by small lamps placed across the track on either side of the crossing,  $Q3$  is switched off and the flashing lights are extinguished. When light to either  $Q1$  or  $Q2$  or both  $Q1$  and  $Q2$  is blocked,  $Q3$ 's gate is positively biased via  $R1$ , thus turning on  $Q3$  and allowing the LEDs to flash.

The circuit is reasonably sensitive considering no amplification is employed beyond the built-in gain of the phototransistors. Either conventional npn phototransistors or photodarlington transistors can be used. For best results, place a short length of black heat-shrinkable tubing over each phototransistor to prevent ambient light from striking the phototransistor's active surface.

Small incandescent lamps can provide adequate illumination for the phototransistors. Infrared LEDs can also be used. Be sure to use a current-limiting resistor between the LED and its power source to restrict the current through the LED to a safe value. To find the value of the resistor, subtract the forward voltage of the LED (probably about 1.3 V) from the supply voltage and divide the result by the desired forward current in amperes.

Though I designed this circuit for model railroad enthusiasts, it has other uses as well. For instance, it can be used to signal a warning when an object or person is present in a certain location. Applications such as this require careful placement of the light-emitting and detecting components and, possibly, the use of external lenses. Additional amplification might also be necessary.

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The new fabrication method, which was explored at IBM by A. E. Blakeslee

as early as 1970, allows semiconductor device designers far more flexibility. Present crystal growth methods limit designers to a handful of compatible semiconductor ingredients. The new fabrication method will greatly expand the potential recipe file of compatible semiconductors and allow designers to concoct a bevy of new devices.

Before finding out more about the new semiconductor fabrication method, let's review the limitations of current technology. Certain classes of highly specialized electronic, photonic and microwave components are now made by growing, one upon another, thin layers of elements from Groups III and V of the periodic table. A prime example is the new generation of semiconductor lasers and light-emitting diodes in which a sandwich-like "heterojunction" is formed by depositing a thin layer of semiconductor having a high refractive index on a layer having a slightly lower index. The structure is completed when a third layer having a low refractive index (similar or identical to the first layer) is grown over the second layer. This sandwichlike structure makes possible highly efficient diode lasers since light emitted in the junction region is kept there by the reflective interfaces between the inner and outer layers.

The problem with heterojunction semiconductors is that the physical dimensions of the crystal lattices of different semiconductors don't match. Therefore, when a layer of one semiconductor is grown atop another, crystal defects called *misfit dislocations* are formed. These defects cause strain within the crystal and act as unwanted recombination centers—that is, small regions that act like pn junctions.

For these reasons, conventional

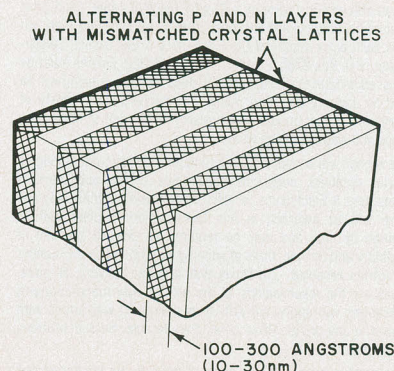


Fig. 8. Formation of a simple strained-layer superlattice device.



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heterojunctions can be made only by combining semiconductor crystals with closely matched lattice structures. This limits the potential number of heterojunction combinations.

**The Sandia Solution.** The scientists at Sandia have perfected a fabrication method that allows the pairing of III-V semiconductors with lattice mismatches ten times as great as before. In the new method, alternating, ultrathin layers of two semiconductors form a structure that resembles that in Figure 8. The structure is called a *strained-layer superlattice* (SLS). The layers are described as "strained" because they are so thin (a few hundred angstroms or less) that they physically *flex* to compensate for the differences in the dimensions of their lattices. Therefore, lattice misfit dislocations do not form when the crystal layers are grown atop one another even when the lattice mismatch is ten times the maximum allowable using conventional crystal growth methods.

Sandia has made an experimental SLS diode consisting of fifty alternating, ultrathin layers of p- and n-type gallium arsenide phosphide (GaAsP), the same compound from which many red light-emitting diodes are made. The diode requires more time to fabricate than conventional diodes, but it offers the potential of as yet unachieved accomplishments.

For example, visible light-emitting laser diodes are very difficult to fabricate due to the lattice mismatch of the materials from which they are made (and other factors). Thus far, only red emitting laser diodes have been made. But according to Dr. Fred L. Vook, Sandia's Director of Solid State Sciences, "With development, one exciting goal for SLS devices would be to generate a green solid-state laser."

Furthermore, wavelengths emitted by existing LEDs and lasers may be generated more efficiently with SLS structures. The Sandia scientists believe that SLS technology will provide much brighter and more colorful LEDs. The new LEDs will be tailor-made and fine-tuned by predetermining the thickness and composition of the SLS layers.

Of course SLS technology is not limited to photonic devices. Dr. Gordon Osbourn, who conducted Sandia's first theoretical study of the SLS concept in 1980, was among the first to realize their vast potential. "I realized that, using SLSs," he recently observed, "one would be free to make devices from materials that aren't lattice-matched. This gives enormous flexibility, for there are

a huge number of these potential structures."

While photonic components, including a new type of solar cell, may be among the earliest practical SLS devices, Sandia scientists have high hopes for SLS microwave and high-speed integrated circuits. Since the SLS research is so new, very little information about the nature of these new devices is currently available. However, serious inquirers *only* can contact Sandia for additional information. Write Public Information Division 3161, Sandia National Laboratories, Box 5800, Albuquerque, NM 87185.

Each year the semiconductor industry introduces a bewildering variety of new components and integrated circuits. While some of the new devices are radically new, most are improved versions of existing devices or technologies. Here's a brief review of some devices in the latter category.

**An Inexpensive Power MOSFET.** Power MOSFET technology is advancing rapidly along two fronts: lower prices and lower on-resistance. A new device with both these advantages is the Siemens BUZ71 EconoFET.

Shown in Fig. 9, the new 50-V power MOSFET has performance and price specifications very similar to those of the popular, industry standard 2N3055 (more than 100 million of which are sold each year). In large quantities, the BUZ71 sells for only \$0.625 each.

The most important technical specification of the BUZ71 is its ultralow on-resistance of typically only 100 milli-

ohms (0.100 ohms). Though earlier MOSFETs have had on-resistances this low and lower, Siemens notes they sell for \$3.50 to \$7.00 each.

The on-resistance of the BUZ71 is lower than that of the 2N3055, and it can be switched with an almost infinitesimally small drive current, a trait it shares with other power MOSFETs. Furthermore, simpler driving circuitry is required. The BUZ71 will switch and carry a continuous current up to 12 A.

How does the EconoFET achieve its ultralow on-resistance? If you've used power MOSFETs in working circuits, you probably know it's possible to parallel two or more such devices to reduce overall on-resistance and increase overall current handling capacity. (As you may know, this same technique can be used with CMOS gates.) Low resistance power MOSFETs like the EconoFET incorporate many hundreds or thousands of individual MOSFETs (or cells) on a single chip. Since the chips are all connected in parallel with one another, their overall on-resistance is very low.

The individual cells of an EconoFET are less than a micron wide. This greatly increases the density of the cells per square millimeter of chip area. If all the cells in a single EconoFET could be separated and lined up side-by-side, they would form a line more than a meter long and less than a micron wide!

Incidentally, if you've not yet used a power MOSFET in a working circuit, you may wonder about all the excitement each time an improved device is announced. The principal advantage of power MOSFETs is the utter simplicity with which they can be switched or linearly modulated. For example, a typical power MOSFET can switch a current of several amperes when its gate is tickled with a negligible current from a CMOS gate. Very little skill is required to design such a simple but effective switching circuit. And, when compared to bipolar circuits, relatively few additional components are required to make all kinds of circuits.

For these reasons, power MOSFETs are finding increasing use in motor control circuits (both dc and stepper), head position drivers for computer disk drives, printhead drivers for impact printers, industrial control circuits, and audio amplifiers.

For more information about power MOSFETs, who makes them and how to use them, see "New Power, MOSFETs" (POPULAR ELECTRONICS, September 1982) and various other articles I've written for this magazine. Also see *Design of VMOS Circuits* by Robert

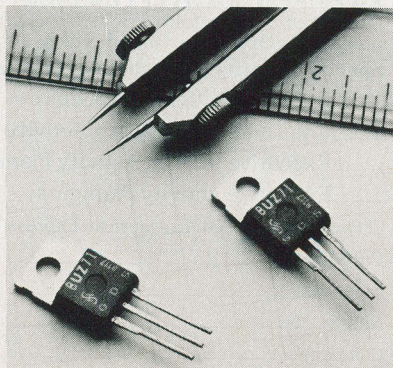


Fig. 9. Siemens' BUZ71 EconoFET can switch up to 12 amperes at 50 volts.



Stone and Howard Berlin (Sams, 1980) and *Getting Started In Electronics* (Radio Shack, 1983).

For more information about the EconoFET, contact a Siemens distributor or write the company (Siemens Components, Inc., Colorado Components Division, 800 Hoyt St., Broomfield, CO 80020).

**A Very Expensive Power MOSFET.** Siliconix now makes a family of power MOSFETs at the opposite end of the price and power spectrum from the Siemens EconoFET. The new family of DMOS devices includes FETs with an on-resistance as low as 35 milliohms.

Designed for very high power applications, these FETs can switch a maximum current of from 40 to 100 A in a pulse mode and from 20 to 60 A in a continuous mode. The maximum breakdown voltage of the new devices ranges from 500 V for the low-current members of the family to 60 V for the high-current devices.

These power MOSFETs are expensive. The six devices range in price (100 quantity) from \$46.15 each for the

VNC003A, a 60-V, 60-A unit, to \$64.10 each for the VN006A, a 500-V, 20-A unit.

The prices for these power FETs are higher than competing bipolar transistors, but the design of their drive circuitry is simpler. Connecting the FETs in parallel will allow up to 10 kW to be switched. And these devices can be effectively used in place of SCRs in high-power switching applications.

Siliconix is an established maker of power MOSFET devices. For more information about their product line and, specifically, very high power MOSFETs, write the company (2201 Laurelwood Rd., Santa Clara, CA 95054) or contact a distributor.

**The ICL7665 Voltage Detector.** The number of battery-powered devices now in use has increased the need for voltage-sensing circuits that indicate when a supply voltage falls below a minimum value. Such circuits can also be used to shut down part or all of a circuit when the supply voltage falls too low.

The ICL7665 is an Intersil voltage detector housed in an 8-pin mini-DIP.

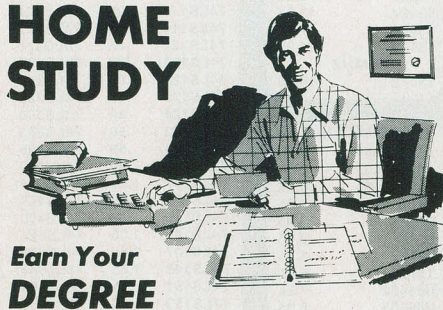
At 9 V, the chip consumes a maximum of 10  $\mu$ A. The typical drain is only 3  $\mu$ A!

The ICL7665 includes two independent voltage detectors, each of which can be programmed by two external resistors to trigger in response to an input voltage ranging from 1.6 to 16 V. A single ICL7665 can monitor two separate supplies. Or half an ICL7665 can indicate a low-battery condition while the second half shuts down all or part of the system being monitored when the voltage falls below the programmed shutdown point.

The two halves of the ICL7665 can also be used to define a voltage detection "window" that indicates when a voltage rises above or falls below a programmed range.

While it would not be too difficult to design a low-power voltage detector from some CMOS comparators or op amps, the ICL7665 is more compact and better suited to the task. In quantities of 100, the chip sells for \$2.34. For more information, contact an Intersil distributor or write the company (10710 North Tantau Ave., Cupertino, CA 95014).

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CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

### TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

### BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

### CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
		74C929	19.95

### 74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

### IC SOCKETS

8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDER TAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIRE WRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call
ZIF = TEXT TOOL (Zero Insertion Force)		

### LED LAMPS

Red	.10	.09
Green	.18	.15
Yellow	.18	.15

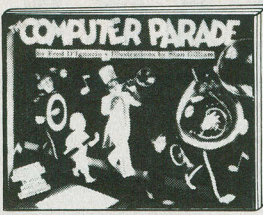
### LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49



LM317K	3.95	LM386N-3	8.95	LM2002T	1.95
LM318CN	8.195	LM749CN	6.39	LM3189N	16.195
LM319N	14.19	LM749CP	6.39	LM3900N	14.19
LM320K-5	1.35	NE531V	8.295	LM3905CN	8.59
LM320K-12	1.35	NE532N	1.95	LM3999N	8.99
LM320K-15	1.35	NE550A	1.95	LM3144N	2.95
LM320T-5	.89	NE555V	3.85	LM3151N	15.89
LM320T-12	.89	LM565N	14.19	LM3161N	16.195
LM320T-15	.89	NE634N	24.69	RC4138N	1.25
LM320T-50	5.95	LM567N	14.19	RC4151NB	8.195
LM324N	14.19	LM568CN	1.49	RC4154K	2.95
LM333N	1.35	LM567V	9.99	NE5532	3.85
LM338K	.69	NE570N	6.39	NE5534	3.85
LM339N	14.69	LM703CN	10.195	ICL8038N	14.195
LM339N-1	1.35	LM707N	14.49	LM1380BN	8.119
LM340K-12	1.35	LM707N	14.49	LM1380BN-1	1.19
LM340K-15	1.35	LM711N	.79		





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FORCE  
SOCKETS —**



cam actuated, true zero insertion — tin plated solder tail pins — capable of being plugged into dip sockets, including wire wrap.

Stock No.	No. of Pins	1-9	10-49	50
11055	24	4.98	\$4.35	\$3.90
11056	28	5.15	4.50	4.05
11057	40	6.81	5.95	5.35
11058	64	12.02	10.50	9.45

**IC-KOOLERS™** from UNITRACK™ dissipate over 2 watts of heat from IC's producing longer life and better performance. Just push IC-Kooler on — heat is collected from top and bottom of IC and dissipated. Won't shake loose!

**WILD ROVER**

Touch switch capsule. Operating motion is .005" without the use of a levered arm. Extremely fast on and off with low noise. Normally open — rated 115 VAC, 1.6 amp-30 milliohm resistance — 615 radius by .160 thick.

Stock No.	1-9	10 & Up
12098	\$1.42	\$1.28

**MIC 6000Z**



**\$7500**

Full 1 year warranty

**DIGITAL MULTIMETER**

Single rotary switch operation. Large, easy to read 5 3/4" digit display 800 hours operating life with single 9V battery. Seven functions — DC Volts, DC Amps, Ohms, AC Volts, AC Amps, Diode and Resistor Junction. Audible Continuity Check.

Stock No. 92504 Carrying case with belt loop **\$10.00**

**TI WIRE  
WRAP  
SOCKETS**

Tin plated phosphor bronze contact — 3 wrap

Stock No.	No. Pins	1-99	100-499	500
11301	8	\$4.00	\$3.36	\$3.30
11302	14	.59	.54	.45
11303	16	.64	.58	.48
11304	18	.73	.66	.55
11305	20	.99	.90	.75
11306	22	1.12	1.02	.85
11307	24	1.25	1.14	.95
11308	28	1.52	1.38	1.15
11309	40	2.05	1.86	1.55

**TI LOW PROFILE  
SOCKETS**

Tin plated copper alloy 688 contact pins with gas tight seal.

Stock No.	No. Pins	1-24	25-99	999
11201	8	\$1.00	\$0.99	\$0.08
11202	14	.14	.13	.12
11203	16	.16	.15	.14
11204	18	.18	.17	.15
11205	20	.20	.18	.16
11206	22	.22	.20	.18
11207	24	.24	.22	.20
11208	28	.28	.26	.25
11209	40	.40	.37	.33

**EKI KITS** come with all parts necessary to assemble!

• Stock No. 88844

TV Jammer Kit "wipes out" your TV

screen .... **\$ 7.71**

• Stock No. 88850

Whooper Alarm Kit makes a great alarm

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**ELPAC POWER SUPPLIES — DC/DC CONVERTERS**

SINTEC Stock No. 300 MW Type	ELPAC No.	Input Voltage (VDC)	Output Voltage (VDC)	Output Current (mA)	Dimensions (HxWxD) in Inches	Price	
13825	CB3801	3.0-7.0	12±0.6	0-25	48x.51x3.05	\$ 7.95	
13826	CB3811	3.0-7.0	12±0.6	0-25	48x.51x3.05	7.95	
13827	CB3802	3.0-7.0	15±0.7	0-20	48x.51x3.05	7.95	
13828	CB3812	3.0-7.0	15±0.7	0-20	48x.51x3.05	7.95	
13829	CB3804	3.0-7.0	28±0.7	0-10	48x.51x3.05	7.95	
13830	CB3814	3.0-7.0	28±0.7	0-10	48x.51x3.05	7.95	
1.5 W TYPE:							
13831	CL3801	4.0-7.0	12±0.6	125	.65x1.2x1.77	\$24.95	
13832	CL3811	4.0-7.0	12±0.6	125	.65x1.2x1.77	24.95	
13833	CL3802	4.0-7.0	15±0.7	100	.65x1.2x1.77	24.95	
13834	CL3812	4.0-7.0	15±0.7	100	.65x1.2x1.77	24.95	
13835	CL3804	4.0-7.0	28±1.4	50	.65x1.2x1.77	24.95	
13836	CL3814	4.0-7.0	28±1.4	50	.65x1.2x1.77	24.95	
13825-1	DATA SHEET FOR DC/DC CONVERTERS						25

**Special of the Month!**

**CONTACT ELECTRONICS  
D-SUBMINIATURE  
CONNECTORS  
(RS232)**

Stock No.	Description	Price
11354	25 Male solder cup	\$1.65
11355	25 Female solder cup	2.45

**OPCOA**

Single Digit Displays — Common Cathode

Stock No.	Color	1	100
12082	Red	\$1.12	\$ .99
12085	Green	1.84	1.63
12087	Yellow	1.92	1.70
12089	Orange	2.08	1.84

Right Angle Socket for Above Displays

Stock No.	1	100
11010	\$1.24	\$ .99

**OPTEL LCD's with pins**

<b>1.8:8.8</b>	Stock No. 47005
<b>8.8:8.8</b>	Stock No. 47006
<b>8.8:8.8</b>	Stock No. 47007

Stock No.	Description	1	10
47005	3 1/2 dig, 5"	\$ 5.95	\$ 5.50
47006	4 dig, 5"	5.95	5.50
47007	4 dig, 7"	11.90	11.00

**The Battery Just Wrap™ Tool**

New battery powered tool wraps insulated wire around .025" square posts without need for pre-cutting and pre-stripping. Complete with bit and 100 ft. 30 AWG wire.

Stock No.	Description	Price
13340	Battery just-wrap tool with bit and 100 ft. 30 AWG wire	\$49.95
13341	Replacement bit	9.95
13342	100 ft. blue replacement wire	6.95
13343	100 ft. white replacement wire	6.95
13344	100 ft. yellow replacement wire	6.95
13345	100 ft. red replacement wire	6.95

**MINI-DRILL**

This portable hand drill is appropriate for circuit board drilling. Runs at 2,500 RPM on 4 "AA" batteries (not included). Supplied with one .039 dia. drill bit. Drill stand is designed like a drill press for precise hole drilling.

Stock No.	Description	Price
13346	Hand drill with .039 dia. bit (no batteries)	\$24.95
13347	Replacement bits, 2 each of .040 and .060 dia.	5.95
13348	Drill stand	13.95

**SOCKET WRAP ID**

DIP socket sized plastic panels with numbered holes in pin for a hole. Significantly reduces wire wrapping to identify pins. Also write on them for location. IC part number function etc. Simplifies initial wire wrapping. Troubleshooting and repair.

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puts IC's on their true row to row spacing. One side is for 300 centers. Flip tool over for devices on 600 centers. Put device in tool and squeeze.

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ONE TOOL DOES 8 thru 40 PINS!  
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2101	256 x 4 (450ns)	1.90
5101	256 x 4 (450ns) (cmos)	3.90
2102-1	1024 x 1 (450ns)	.88
2102L-4	1024 x 1 (450ns) (LP)	.98
2102L-2	1024 x 1 (250ns) (LP)	1.45
2111	256 x 4 (450ns)	2.45
2112	256 x 4 (450ns)	2.95
2114	1024 x 4 (450ns)	8/9.90
2114-25	1024 x 4 (250ns)	8/8.95
2114L-4	1024 x 4 (450ns) (LP)	8/11.95
2114L-3	1024 x 4 (300ns) (LP)	8/12.45
2114L-2	1024 x 4 (200ns) (LP)	8/12.95
2147	4096 x 1 (55ns)	4.90
TMS4044-4	4096 x 1 (450ns)	3.45
TMS4044-3	4096 x 1 (300ns)	3.95
TMS4044-2	4096 x 1 (200ns)	4.45
MK4118	1024 x 8 (250ns)	9.90
TMM2016-200	2048 x 8 (200ns)	4.10
TMM2016-150	2048 x 8 (150ns)	4.90
TMM2016-100	2048 x 8 (100ns)	6.10
HM6116-4	2048 x 8 (200ns) (cmos)	4.70
HM6116-3	2048 x 8 (150ns) (cmos)	4.90
HM6116-2	2048 x 8 (120ns) (cmos)	8.90
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.90
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.90
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	9.95
Z-6132	4096 x 8 (300ns) (Qstat)	33.95

LP = Low Power Qstat = Quasi-Static

## DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.95
UPD411	4096 x 1 (300ns)	2.95
MMS280	4096 x 1 (300ns)	2.95
MK4108	8192 x 1 (200ns)	1.90
MMS298	8192 x 1 (250ns)	1.80
4116-300	16384 x 1 (300ns)	8/10.75
4116-250	16384 x 1 (250ns)	8/10.95
4116-200	16384 x 1 (200ns)	8/11.95
4116-150	16384 x 1 (150ns)	8/13.95
4116-120	16384 x 1 (120ns)	8/28.95
2118	16384 x 1 (150ns) (5v)	4.90
4164-200	65536 x 1 (200ns) (5v)	5.90
4164-150	65536 x 1 (150ns) (5v)	6.90

5V = single 5 volt supply

## EPROMS

1702	256 x 8 (1us)	4.45
2708	1024 x 8 (450ns)	3.90
2758	1024 x 8 (450ns) (5v)	5.90
2716	2048 x 8 (450ns) (5v)	3.90
2716-1	2048 x 8 (350ns) (5v)	5.90
TMS2516	2048 x 8 (450ns) (5v)	5.45
TMS2716	2048 x 8 (450ns)	7.90
TMS2532	4096 x 8 (450ns) (5v)	5.90
2732	4096 x 8 (450ns) (5v)	4.90
2732-250	4096 x 8 (250ns) (5v)	8.90
2732-200	4096 x 8 (200ns) (5v)	10.95
2764	8192 x 8 (450ns) (5v)	9.90
2764-250	8192 x 8 (250ns) (5v)	13.95
2764-200	8192 x 8 (200ns) (5v)	23.95
TMS2564	8192 x 8 (450ns) (5v)	16.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	38.95
27128	16384 x 8Call	Call

5v = Single 5 Volt Supply

## 74LS00

74LS00	.23	74LS173	.68
74LS01	.24	74LS174	.54
74LS02	.24	74LS175	.54
74LS03	.24	74LS181	2.10
74LS04	.23	74LS189	8.90
74LS05	.24	74LS190	.88
74LS08	.27	74LS191	.88
74LS09	.28	74LS192	.78
74LS10	.24	74LS193	.78
74LS11	.34	74LS194	.68
74LS12	.34	74LS195	.68
74LS13	.44	74LS196	.78
74LS14	.58	74LS197	.78
74LS15	.34	74LS221	.88
74LS20	.24	74LS240	.94
74LS21	.28	74LS241	.98
74LS22	.24	74LS242	.98
74LS26	.28	74LS243	.98
74LS27	.28	74LS244	1.25
74LS28	.34	74LS245	1.45
74LS30	.24	74LS247	.74
74LS32	.28	74LS248	.98
74LS33	.54	74LS249	.98
74LS37	.34	74LS251	.58
74LS38	.34	74LS253	.58
74LS40	.24	74LS257	.58
74LS42	.48	74LS258	.58
74LS47	.74	74LS259	2.70
74LS48	.74	74LS260	.58
74LS49	.74	74LS266	.54
74LS51	.24	74LS273	1.45
74LS54	.28	74LS275	3.30
74LS55	.28	74LS279	.48
74LS63	1.20	74LS280	1.95
74LS73	.38	74LS283	.68
74LS74	.34	74LS290	.88
74LS75	.38	74LS293	.88
74LS76	.38	74LS295	.98
74LS78	.48	74LS298	.88
74LS83	.59	74LS299	1.70
74LS85	.68	74LS323	3.45
74LS86	.38	74LS324	1.70
74LS90	.54	74LS352	1.25
74LS91	.88	74LS353	1.25

74LS92	.54	74LS363	1.30
74LS93	.54	74LS364	1.90
74LS95	.74	74LS365	.48
74LS96	.88	74LS366	.48
74LS107	.38	74LS367	.44
74LS109	.38	74LS368	.44
74LS112	.38	74LS373	1.35
74LS113	.38	74LS374	1.35
74LS114	.38	74LS377	1.35
74LS122	.44	74LS378	1.13
74LS123	.78	74LS379	1.30
74LS124	2.85	74LS385	1.85
74LS125	.48	74LS386	.44
74LS126	.48	74LS390	1.15
74LS132	.58	74LS393	1.15
74LS133	.58	74LS395	1.15
74LS136	.38	74LS399	1.45
74LS137	.98	74LS424	2.90
74LS138	.54	74LS447	.36
74LS139	.54	74LS490	1.90
74LS145	1.15	74LS624	3.95
74LS147	2.45	74LS640	2.15
74LS148	1.30	74LS645	2.15
74LS151	.54	74LS668	1.65
74LS153	.54	74LS669	1.85
74LS154	1.85	74LS670	1.45
74LS155	.68	74LS674	9.60
74LS156	.68	74LS682	3.15
74LS157	.64	74LS683	3.15
74LS158	.58	74LS684	3.15
74LS160	.68	74LS685	3.15
74LS161	.64	74LS688	2.35
74LS162	.68	74LS689	3.15
74LS163	.64	74LS783	23.95
74LS164	.68	81LS95	1.45
74LS165	.94	81LS96	1.45
74LS166	1.90	81LS97	1.45
74LS168	1.70	81LS98	1.45
74LS169	1.70	25LS2521	2.75
74LS170	1.45	25LS2569	4.20

## 6500 1MHZ

6502	4.90
6504	6.90
6505	8.90
6507	9.90
6520	4.30
6522	7.90
6532	9.90
6545	21.50
6551	10.85

## 2 MHZ

6502A	6.90
6522A	9.90
6532A	10.95
6545A	26.95
6551A	10.95

## 3 MHZ

6502B	13.95
-------	-------

## 6800

68000	58.95
6800	3.90
6802	7.90
6808	12.90
6809E	18.95
6809	10.95
6810	2.90
6820	4.30
6821	3.20
6828	13.95
6840	11.95
6843	33.95
6844	24.95
6845	13.95
6847	10.95
6850	3.20
6852	15.70
6860	9.90
6862	10.95
6875	6.90
6880	2.20
6883	21.95
68047	23.95
68488	18.95

## 6800 1MHZ

68B00	9.95
68B02	21.25
68B09E	28.95
68B09	28.95
68B10	6.90
68B21	6.90
68B45	18.95
68B50	5.90

## 8000

8035	5.90
8039	6.90
INS-8060	16.95
INS-8073	23.95
8080	3.90
8085	5.90
8085A-2	10.95
8086	28.95
8087	CALL
8088	38.95
8089	88.95
8155	6.90
8155-2	7.90
8156	6.90
8185	28.95
8185-2	38.95
8741	38.95
8748	23.95
8755	23.95



## 8200

8202	23.95
8203	38.95
8205	3.45
8212	1.75
8214	3.80
8216	1.70
8224	2.20
8226	1.75
8228	3.45
8237	18.95
8237-5	20.95
8238	4.45
8243	4.40
8250	9.95
8251	4.45
8253	6.90
8253-5	7.90
8255	4.45
8255-5	5.20
8257	7.90
8257-5	8.90
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
8275	28.95
8279	8.90
8279-5	9.00
8272	6.45
8283	6.45
8284	5.45
8286	6.45
8287	6.45
8288	24.00
8289	48.95

## Z-80

### 2.5 Mhz

Z80-CPU	3.90
Z80-CTC	4.45
Z80-DART	9.95
Z80-DMA	13.95
Z80-PIO	4.45
Z80-SIO/0	15.95
Z80-SIO/1	15.95
Z80-SIO/2	15.95
Z80-SIO/9	15.95

### 4.0 Mhz

Z80A-CPU	4.90
Z80A-CTC	4.90
Z80A-DART	10.95
Z80A-DMA	15.95
Z80A-PIO	4.90
Z80A-SIO/0	15.95
Z80A-SIO/1	15.95
Z80A-SIO/2	15.95
Z80A-SIO/9	15.95

### 6.0 Mhz

Z80B-CPU	12.95
Z80B-CTC	12.95
Z80B-PIO	12.95
Z80B-DART	18.95

## ZILOG

Z6132	33.95
Z8671	38.95

## DISC CONTROLLERS

1771	15.95
1791	23.95
1793	25.95
1795	48.95
1797	48.95
1791	53.95
1793	53.95
1795	58.95
1797	58.95
6843	33.95
8272	38.95
UPD765	38.95
MB8876	28.95
MB8877	33.95
1691	16.95
2143	17.95

## UARTS

AY3-1014	6.90
AY5-1013	3.90
AY3-1015	6.90
PT-1472	9.90
TR1602	3.90
2350	9.90
2651	8.90
TMS8011	5.90
IM6402	7.90
IM6403	8.90
INS8250	9.95

## INTERFACE

8T26	1.54
8T28	1.84
8T95	.88
8T96	.88
8T97	.88
8T98	.88
DM8131	2.90
DP8304	2.24
DS8835	1.94
DS8836	.98

## VOLTAGE REGULATORS

7805T	.74	7905T	.84
78MO5C	.34	7908T	.84
7808T	.74	7912T	.84
7812T	.74	7915T	.84
7815T	.74	7924T	.84
7824T	.74	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
78L05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

C, T = TO-220 K = TO-3 L = TO-92

## DIP SWITCHES

4 POSITION	.84
5 POSITION	.89
6 POSITION	.89
7 POSITION	.94
8 POSITION	.94

## IC SOCKETS

	1-99	100
8 pin ST	.12	.10
14 pin ST	.14	.11
16 pin ST	.16	.12
18 pin ST	.19	.17
20 pin ST	.28	.26
22 pin ST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40 pin ST	.48	.38
64 pin ST	4.20	call

ST = SOLDERTAIL

8 pin WW	.58	.48
14 pin WW	.68	.51
16 pin WW	.68	.57
18 pin WW	.98	.89
20 pin WW	1.04	.97
22 pin WW	1.34	1.23
24 pin WW	1.44	1.30
28 pin WW	1.64	1.44
40 pin WW	1.94	1.75

WW = WIREWRAP

16 pin ZIF	6.70	call
24 pin ZIF	9.90	call
28 pin ZIF	9.95	call

ZIF = TEXTTOOL (Zero Insertion Force)

## CRYSTALS

32.768khz	1.90
1.0 mhz	4.90
1.8432	4.90
2.0	3.90
2.097152	3.90
2.4576	3.90
3.2768	3.90
3.579535	3.90
4.0	3.90
5.0	3.90
5.0698	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
18.0	3.90
18.432	3.90
20.0	3.90
22.1184	3.90
32.0	3.90

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Z80 Card	129.95
SCRG Switch-A-Slot	19.95
Paddle Adapple	24.95
Extend-A Slot	19.95
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Controller Card	69.95

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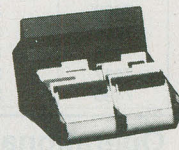
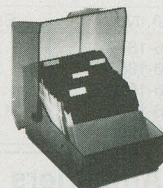
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- Expandable from 16K to 64K

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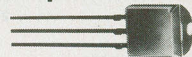
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Type		Cat. No.	Each
2N1305	PNP	276-2007	1.19
MPS222A	NPN	276-2009	.79
PN2484	PNP	276-2010	.89
MPS3904	NPN	276-2016	.69
TIP31	NPN	276-2017	.99
TIP3055	NPN	276-2020	1.59
MPS2907	PNP	276-2023	.79
MJE34	PNP	244-2027	1.49
2N3053	NPN	276-2030	.89
MPS3638	PNP	276-2032	.79
TIP120	NPN	276-2068	1.29
2N3055	NPN	276-2041	1.99
MJ2955	PNP	276-2043	2.19
2N4124	NPN	276-2057	.59
2N4401	NPN	276-2058	.59
MPSA06	NPN	276-2059	.59
MPSA13	NPN	276-2060	.59
MPSA42	NPN	276-2061	.69
MU4891	UJT	276-2029	.99
2SD313	NPN	276-2048	1.79
2SC945	NPN	276-2051	.79
2SC1308	NPN	276-2055	7.95
2N3819	N-FET	276-2035	.99
MPF102	N-FET	276-2062	.99

## 4000-Series CMOS ICs



With Pin-Out  
And Specs

Type	Cat. No.	Each
4001	276-2401	.79
4011	276-2411	.79
4013	276-2413	.99
4017	276-2417	1.49
4023	276-2423	.99
4049	276-2449	.99
4066	276-2466	.99

## TTL Digital ICs With Pin-Out and Specs

Type	Cat. No.	Each
7400	276-1801	.59
7404	276-1802	.79
7408	276-1822	.79
7447	276-1805	1.19
7490	276-1808	.39

## Operational Amplifiers



Type		Cat. No.	Each
741	(Single)	276-007	.79
MC1458	(Dual)	276-038	.99
LM324	(Quad)	276-1711	1.29
TL082	(Dual)	276-1715	1.89
TL084C	(Quad)	276-1714	2.99
LM3900	(Quad)	276-1713	1.39
LM339	(Quad)	276-1712	1.49

## Voltage Regulator ICs



Type	Adjustable	Cat. No.	Each
LM723	0 to 40 VDC	276-1740	.89
LM317T	1.2 to 37 VDC	276-1778	2.79
Type	Fixed Output	Cat. No.	Each
7805	+5 VDC	276-1770	1.59
7812	+12 VDC	276-1771	1.59
7815	+15 VDC	276-1772	1.59
7905	-5 VDC	276-1773	1.59
7912	-12 VDC	276-1774	1.59

## Computer Connectors

Type	Positions	Cat. No.	Each
ID Card Edge	34	276-1564	4.95
ID Card Edge	50	276-1566	4.95
Card-Edge Socket	44	276-1551	2.99
ID D-Sub Male	25	276-1559	4.99
ID D-Sub Female	25	276-1565	4.99
Solder D-Sub Male	25	276-1547	2.99
Solder D-Sub Female	25	276-1548	3.99
Hood	—	276-1549	1.99
D-Sub Solder Male	9	276-1537	1.99
D-Sub Solder Female	9	276-1538	2.49
Hood	—	276-1539	1.99

## Tantalum Capacitors

- 20% Tolerance
- Standard IC Pin Spacing



μF	WVDC	Cat. No.	Each
0.1	35	272-1432	.49
0.47	35	272-1433	.49
1.0	35	272-1434	.49
2.2	35	272-1435	.59
10	16	272-1436	.69
22	16	272-1437	.79

## Power Transformers 120VAC Primaries

Type	Volts	Current	Cat. No.	Each
Mini	6.3	300 mA	273-1384	2.59
Mini	12.0	300 mA	273-1385	2.79
Mini	24.0	300 mA	273-1386	2.99
Mini	12.0 CT	450 mA	273-1365	3.59
Mini	24.0 CT	450 mA	273-1366	3.99
Std.	6.3	1.2A	273-050	3.79
Std.	12.6 CT	1.2A	273-1505	3.99
Std.	25.2	1.2A	273-1480	4.39
H-D	12.6 CT	3.0A	273-1511	5.99
H-D	25.2 CT	2.0A	273-1512	6.29
H-D	18.0 CT	2.0A	273-1515	6.99

## 1/4-Watt, 5% Resistors

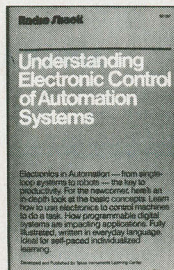
39¢ Pkg. of 5

Ohms	Cat. No.	Ohms	Cat. No.
10	271-1301	10k	271-1335
100	271-1311	15k	271-1337
150	271-1312	22k	271-1339
220	271-1313	27k	271-1340
270	271-1314	33k	271-1341
330	271-1315	47k	271-1342
470	271-1317	68k	271-1345
1k	271-1321	100k	271-1347
1.8k	271-1324	220k	271-1350
2.2k	271-1325	470k	271-1354
3.3k	271-1328	1 meg	271-1356
4.7k	271-1330	10 meg	271-1365
6.8k	271-1333	—	—

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pF	Cat. No.	Pkg. of 2	μF	Cat. No.	Pkg. of 2
4.7	272-120	.39	.001	272-126	.39
47	272-121	.39	.005	272-130	.39
100	272-123	.39	.01	272-131	.39
220	272-124	.39	.05	272-134	.49
470	272-125	.39	.1	272-135	.49

## Miniature PC-Mount Potentiometers



1/8-Watt, Horizontal-Mount

Ohms	Cat. No.	Each
1k	271-333	.49
10k	271-335	.49
25k	271-336	.49
100k	271-338	.49
500k	271-339	.49

1/4-Watt, Vertical-Mount

Ohms	Cat. No.	Each
500	271-226	.59
1k	271-227	.59
5k	271-217	.59
10k	271-218	.59
50k	271-219	.59
100k	271-220	.59
500k	271-221	.59
1 meg	271-229	.59

## Micro-Mini Toggle Switches



Top quality! Rated 3 amps at 125 VAC. Body: 1/4 x 5/16 x 3/16". Mounting hole: 3/8". Solder lugs.

Type	Cat. No.	Each
SPST	275-624	1.49
SPDT	275-625	1.59
DPDT	275-626	1.89

## Flatted-Lever Switches



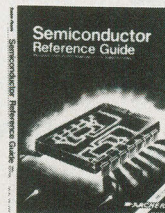
Rated 6 amps at 125VAC. Body: 3/8 x 7/16 x 1/4". Require 1/4" mounting holes.

Type	Cat. No.	Each
SPDT	275-635	2.39
DPDT	275-636	2.69

DPDT Momentary. Same size and rating as above, with spring return to center-off position. **275-637 ..... 2.89**

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





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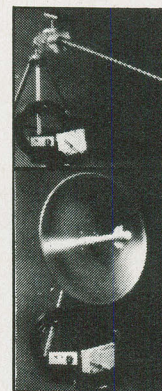


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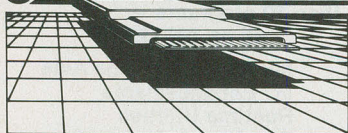
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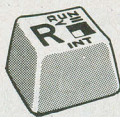








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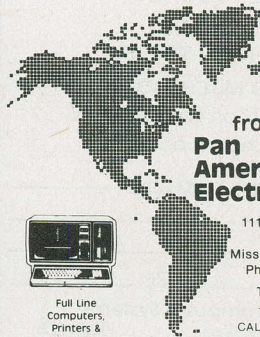
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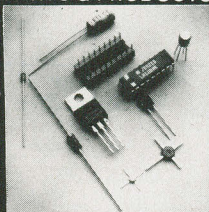
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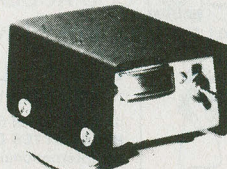
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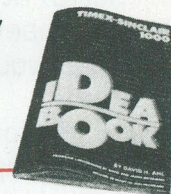
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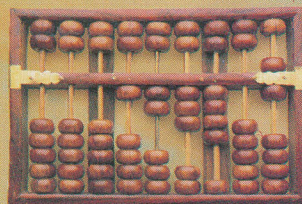


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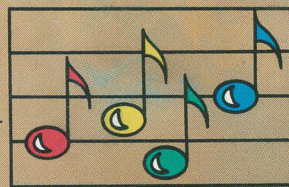


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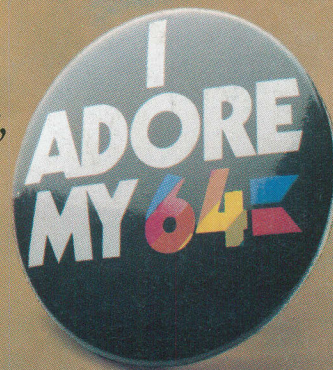
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